LESSON STUDY AS A MANAGEMENT STRATEGY TO IMPROVE PERFORMANCE IN SPACE, SHAPE AND ORIENTATION IN MATHEMATICAL LITERACY AT TECHNICAL AND VOCATIONAL EDUCATION AND TRAINING COLLEGES

by

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DEDICATION

This study is dedicated to the memory of my late parents, Ghulaam and Rabia Hassan.

I also dedicate this work to my loving wife, Rukeyah Hassan, my two sons, Saeed and Akeel Hassan, and my six sisters.

ABSTRACT

This study investigated how lesson study, a Japanese intervention tool, may be used as a management strategy to improve performance in space, shape and orientation in Mathematical Literacy at Technical and Vocational Education and Training colleges.

In this study a qualitative approach was followed in both the pilot and the main study. Prior to the main study, a small-scale pilot study was conducted which consisted of two participant lecturers and lasted for about two months culminating in one complete lesson study cycle and a second partially completed cycle.

Four lecturers participated in the main study which lasted about seven months from the last week of February 2019 to the last week of August 2019 at a campus of a TVET college where Mathematical Literacy is a subject in the NCV program. Data were collected from semi-structured interviews with lecturers and students, observations of students' performance and behaviour while delivering the research lessons, including researchers' journals and participant lecturers' journals, students' work and meeting notes which included debriefing notes.

The LS - Participative Management model proposed in this study has shown to achieve the broad teaching and learning outcomes, personal and professional outcomes and managerial outcomes. Hence, it is possible that the model proposed in this study is an appropriate model which can be successfully implemented at TVET colleges in South Africa.

With the application of the LS Participative Management model, findings revealed from this study showed that participant lecturers improved their teaching and learning by reflecting and engaging with the content of space, shape and orientation in Mathematical Literacy by highlighting the misconceptions students have around this topic. Participant lecturers were also brought out of isolation, giving them the opportunity to collaborate with other lecturers and the manager. Collaboration and participation in lesson study also brought about organisational effectiveness which was revealed through vigorous discussions, openness, trust and respect, positive

relationships and sharing ideas. Lesson study also provided an enabling environment for lecturers to become personally and professionally empowered by increased confidence and motivation as they gained more experience in lesson study.

The involvement of the manager as a participant observer showed that it can impact on curriculum management, sharing experience and expertise, influence the organisational culture and provide guidance and support.

KEY TERMS:

Lesson study; space and shape; lesson plans; Mathematics; Mathematical Literacy; management; management strategy; leadership; participative management; colleges; TVET colleges; social constructivism; social cognitive theories; community of practice theory.

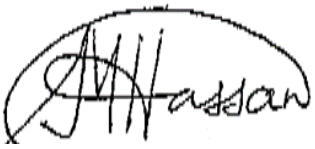
DECLARATION

LESSON STUDY AS A MANAGEMENT STRATEGY TO IMPROVE PERFORMANCE IN SPACE, SHAPE AND ORIENTATION IN MATHEMATICAL LITERACY AT TECHNICAL AND VOCATIONAL EDUCATION AND TRAINING COLLEGES

I declare that this thesis is my own work and that all the sources that I used or quoted are indicated and acknowledged by means of complete references.

I further declare that I submitted the thesis to originality checking software and that it fell within the accepted requirements for originality.

I further declare that I have not previously submitted this work, or part of it, for examination at UNISA for another qualification or at any other higher education institution.



SIGNATURE

27 November 2020

DATE

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LIST OF ACRONYMS

ACRONYM	Explanation
LS	Lesson study
NC(V)	National Curriculum Vocational
PM	Participative Management
TVET	Technical and Vocational Education and Training
ML	Mathematical Literacy
CHE	Council on Higher Education
QCTO	Quality Council for Trades and Occupations
CAPS	Curriculum and Assessment Policy Statement
NCS	National Curriculum Statement
NQF	National Qualifications Framework
DHET	Department of Higher Education and Training
FET	Further Education and Training
TIMSS	Trends in International Mathematics and Science Study
PD	Professional Development
CPD	Continuous Professional Development
FG	Focus Group
SO	Subject Outcomes
LO	Learning Outcomes
IL	Instructional Leadership
PDM	Participative Decision Making
ZPD	Zone of Proximal Development
CoP	Communities of Practice
PCK	Pedagogical content knowledge
OCB	Organisational Citizenship Behaviour
PL	Participant Lecturer
PPL	Pilot Participant Lecturer
R	Researcher

CHAPTER 1
INTRODUCTION

1.1 OVERVIEW OF THE STUDY

This chapter gives the background and introduces readers to the study. It focuses on the statement of the problem, provides the rationale and purpose of the study and gives the main research question and sub-questions. A brief summary of both the literature reviewed together with the theoretical framework that underpins the study is presented. Moreover, a brief reference is made to the methodology used and its components such as the research design, background of the participants, the sample used and the research site. It then briefly refers to the limitations of the study. Lastly, it outlines a summary of the components of every chapter of the study as well as explanations and/or definitions of the key terms in the study.

1.2 BACKGROUND

The subject Mathematical Literacy (ML) was introduced at schools in 2006 and at TVET colleges in 2007 as a compulsory alternative to Mathematics. This was done with the objective of allowing every citizen to have some form of mathematical skill which they can use in their personal and work-related lives (DHET Subject Guidelines NC(V), 2013:2). Although the intention was good, not all the objectives of the subject had been reached. The objective of ML becoming a high-quality subject that could stand independently with its own set of objectives, and not be compared with Mathematics, is one that was not accomplished. This was due to the fact that its objectives were not appropriately communicated (Nkosi, 2016:1). In addition, a major concern was Umalusi's announcement in 2016 that the "needle for Mathematics has not moved", which meant that there had been no significant improvement and noticeable difference in the marks for Mathematics since 2014. Equally shocking was the announcement that ML had also not shown any improvement from 2014 to 2016 (Umalusi Report, 2016:2).

Umalusi, the Council for Quality Assurance in General and Further Education and Training, is one of three quality councils in South Africa; the other two are the Council for Higher Education (CHE) and the Quality Council for Trades and Occupations (QCTO), whose role is to develop an education framework and manage the standard of qualifications for General and Further Education and Training in South Africa. Part of Umalusi's function is to issue and verify various qualifications such as the National Senior Certificate, vocational qualifications as well as Adult Education and Training qualifications (Umalusi, 2012:2). The main functions of this body are to set standards for assessment of qualifications on the General and Further Education and Training Qualifications Framework and to ensure that assessment for certification in schools, Further Education and Training colleges and Adult Education and Training centres are of the required standard (Matshoba, 2013). In the context of ML, it oversees the standards of assessments and verifies the certification of the curriculum (Matshoba, 2013).

Mathematical Literacy which is a context-driven subject must be taught and learnt from a contextual framework (DoE, 2011, 2003). According to the subject guidelines for ML, it is meant to equip students to deal effectively with everyday problems. According to the Curriculum and Assessment Policy Statement (CAPS) curriculum documents (DoE 2011:8), Mathematical Literacy is defined as follows:

The competencies developed through Mathematical Literacy allow individuals to make sense of, participate in and contribute by becoming responsible citizens who base their decisions on sound information in the twenty-first century world, a world characterised by numbers, numerically-based arguments and data represented and misrepresented in a number of different ways. Such competencies include the ability to reason, make decisions, solve problems, manage resources, interpret information, schedule events and use and apply technology (DoE, 2011:8).

What may be gleaned from the above statement is that it allows citizens to make informed decisions and choices after carefully considering all information in its contexts by comparing, conjecturing, calculating and problem solving through the use of numbers and by using and applying technology to assist them. It further states that citizens will

be allowed to utilise resources, human or otherwise, in a very optimal manner based on their calculations. Although the above was an expected outcome of the implementation of ML, not much research has been done to verify whether this is what is actually happening in real life for those students who have done the ML program at schools and TVET colleges.

It is therefore important that managers must be at the forefront of devising strategies to improve performance in this subject by creating empowerment strategies aimed at improving classroom practice and focusing on improved teaching through better lesson planning which incorporates elements and components of how students learn.

On the contrary, a worrying fact is displayed in Table 1.1. The table reflects a decline in performance in the Mathematical Literacy NCS curriculum between the years 2012 and 2015 country wide:

Table 1.1: Decline in performance in Mathematical Literacy in the NCS curriculum between 2012 and 2015.

Subjects (Full-Time)	2012			2013			2014			2015		
	Wrote	Achieved 30% & Above	% Achieved	Wrote	Achieved 30% & Above	% Achieved	Wrote	Achieved 30% & Above	% Achieved	Wrote	Achieved 30% & Above	% Achieved
Accounting	134 978	88 508	65.6	145 427	95 520	65.7	125 987	85 681	68.0	140 474	83 747	59.6
Agricultural Science	78 148	57 571	73.7	83 437	67 308	80.7	78 063	64 486	82.6	104 251	80 125	76.9
Business Studies	195 507	151 237	77.4	218 914	179 329	81.9	207 659	161 723	77.9	247 822	187 485	75.7
Economics	134 369	97 842	72.8	150 114	110 869	73.9	137 478	94 779	68.9	165 642	112 922	68.2
Geography	213 735	162 046	75.8	239 657	191 834	80.0	236 051	191 966	81.3	303 985	234 209	77.0
History	94 489	81 265	86.0	109 046	94 982	87.1	115 686	99 823	86.3	154 398	129 643	84.0
Life Orientation	522 132	520 502	99.7	569 530	568 311	99.8	542 956	540 810	99.6	660 202	658 308	99.7
Life Sciences	278 412	193 593	69.5	301 718	222 374	73.7	284 298	209 783	73.8	348 076	245 164	70.4
Mathematical Literacy	291 341	254 611	87.4	324 097	282 270	87.1	312 054	262 495	84.1	388 845	277 594	71.4
Mathematics	225 874	121 970	54.0	241 509	142 666	59.1	225 458	120 523	53.5	263 903	129 481	49.1
Physical Science	179 194	109 918	61.3	184 383	124 206	67.4	167 997	103 348	61.5	193 189	113 121	58.6

At TVET colleges in the NC(V) curriculum the situation does not appear to be much different for Mathematical Literacy as Table 1.2 indicates:

Table 1.2: Comparison of performance between actual achievement and planned achievement between 2014 and 2015 in Mathematical Literacy at TVET colleges.

Actual Achievement 2013/14	**Planned Target for 2014/15**	**Actual Achievement 2014/15**	
NC(V) L2: 67.4%	**NC(V) L2: 72%**	**NC(V) L2: 70.5%**	**Not achieved**
NC(V) L3: 80.3%	**NC(V) L3: 82%**	**NC(V) L3: 82.4%**	**Achieved, but only exceeding by 0.4%**
NC(V) L4: 82.2%	**NC(V) L4: 87%**	**NC(V) L4: 78.7%**	**Not achieved**

According to Table 1.2, the big concern is the decline in the results from 82,2% to 78,7% for the level 4 NC(V) exit students from 2014 to 2015, apart from not achieving the target of 87%. At the exit level, after three years of consistent interaction with the subject, one would expect the opposite to happen. The exit level, which is level 4 of the NCV curriculum at TVET colleges, is equivalent to the matric NCS school leaving certificate and is also equivalent to a level 4 qualification on the National Qualifications Framework (NQF). This qualification allows students to pursue a post school qualification.

According to the subject guidelines for Mathematical Literacy (DHET Subject Guidelines NC(V), 2013:4), each of the 5 topics occupies exactly 20% of the curriculum and, depending on the complexity of the topic, the face-to-face teaching hours differ as shown in the following table:

Table 1.3*:* Weighted Values of Topics in the Level 2 Mathematical Literacy Curriculum 2013

Topic	Weighted Value	Teaching Hours
1. Numbers	20	30
2. Space, shape and orientation	20	25
3. Finance	20	25
4. Patterns, relationships and presentations	20	15
5. Data handling	20	15
Total	**100**	**110**

Source: DHET Subject Guidelines NC(V), 2013)

As far as the assessment guidelines of the subject ML are concerned, there are eight continuous formative assessments throughout the year, each one entailing 10% of the continuous mark. The June examination (covering Topics 1, 2 and 3) covers 20% and the internal examinations cover 30%. The internal examination consists of two papers, covering 15% of the 30% with Paper 2 set at a much higher cognitive level than Paper 1. There are 5 questions in Paper 1, each covering one topic of the 5 entailing 20% each, whereas Paper 2 consists of 4 questions covering only 4 of the topics with no direct questions on Topic 1 (numbers) as it is integrated within the 4 topics. Each of the 4 questions in Paper 2 covers 25%. Since the second, third and fifth (June) assessments contain questions on space, shape and orientation, consisting of roughly 30% on space, shape and orientation throughout the year. The situation is clearly depicted in Table 1.4 below:

Table 1.4: Assessment coverage, percentage and topic coverage for the 8 assessments for the Level 2 NC(V) Mathematical Literacy curriculum at TVET colleges

Assess-ment	**1**	**2**	**3**	**4**	**5 June Exams**	**6**	**7 Paper 1**	**8 Paper 2**
% coverage	**10%**	**10%**	**10%**	**10%**	**20%**	**10%**	**15%**	**15%**
Topics covered	Topic 1	Topic 1 and a little of Topic 2	Topic 2	Topic 3	Topics 1, 2 and 3	Topics 4 and 5	All topics	All topics

Source: DHET Assessment Guidelines for Level 2 NCV Mathematical Literacy Curriculum 2013 Adapted

Hence, if students do poorly in these assessments, they would be unable to achieve the 30% required to pass for two reasons: they struggle and more work is tested on this part of the work.

Students who do Mathematics or Mathematical Literacy both struggle with the topic of Space, Shape and Orientation at all levels (level 2 to level 4) and especially with problems of a contextual nature related to space, shape and orientation. From classroom observations, assessments and examinations it has also been found that students perform worst in the topic of Space, Shape and Orientation. It has been observed that most students provide incorrect responses to questions addressing perimeter, area and volumes as well as related contextual questions, or they omit these questions.

A summary of a random sample of data extracted from only the September examination of Paper 2 for the Level 2 NC(V) students of 2015 and 2016 revealed the following:

Table 1.5: Summarised September results of a TVET college campus for Mathematical Literacy 2015 – Paper 2

Range in %	Numbers	Patterns and relationships	Space, shape and orientation	Finance	Data handling
0-29%	**7**	**14**	**14**	**20**	**8**
30-39%	**8**	**6**	**7**	**1**	**0**
40-49%	**5**	**1**	**3**	**1**	**4**
50-59%	**3**	**1**	**2**	**0**	**5**
60-69%	**1**	**4**	**0**	**2**	**7**
70- 79%	**1**	**0**	**0**	**0**	**3**
80-100%	**2**	**1**	**1**	**3**	**0**

Table 1.5 above for 2015 clearly shows that more than 80% of this sample of students scored less than 50%, while more than 50% (14 students) scored between 0-29% or below 30% for space, shape and orientation.

Table 1.6: Summarised September results of a TVET college campus for Mathematical Literacy 2016 – Paper 2

Range in %	Patterns and relationships	Finance	Space, shape and orientation	Data Handling
0-29%	**2**	**4**	**15**	**11**
30-39%	**4**	**3**	**2**	**3**
40-49%	**6**	**7**	**2**	**2**
50-59%	**3**	**2**	**1**	**2**
60-69%	**5**	**3**	**2**	**2**
70- 79%	**1**	**3**	**1**	**3**
80-100%	**3**	**2**	**1**	**1**

In Table 1.6 it is even more obvious that students performed very poorly in this section of the work: 80% of students scored below 50% and roughly 63% (which is a higher percentage than in 2015) scored between 0 - 29%. Compared to the other sections, more students scored between 0 – 29% in space, shape and orientation in the examinations. Hence, from both tables it can clearly be concluded that students struggle with this section of the work. They perform poorly in it and, compared to the other sections, their performance is weak which could also be one of the reasons why their total mark is poor. Space, shape and orientation occupy 20% of the curriculum as mentioned earlier.

1.2.1 Lesson study: A brief literature review

It has been recognised by many authors on Mathematics education that teachers are heavily influenced in their teaching by their own experience at school and then teach in a similar way to how they themselves were taught (Burghess & Robinson, 2010:11-12). The format and structure at most schools follow the traditional lesson>examples>exercises route. This has resulted in the overall poor performance in Mathematics and ML at schools and TVET colleges, and compelled schools, colleges and universities to launch intervention programs to improve performance in ML. These intervention programs took the form of revising the work and giving learners a set of exercises with no situations for solving real-life problems and problems for which solutions have to be found by creating solutions collaboratively.

According to Esterhuyse (2005:2), these traditional methods of teaching lead to poor performance in mathematical subjects as teachers and lecturers only concentrate on what must be taught and seldom consider how students learn, as students are passive participants in this traditional method. Esterhuyse (2005:2) further emphasises the fact that a Mathematics classroom should be an interactive environment, where learners are encouraged to discover problems (and solutions) and where discussions take place. Burghess and Robinson (2010:11-12) believe that to improve performance through teaching, focus must be placed on the way it is taught and therefore they advocate the development of effective models of teaching and recognise the potential of LS as a strong model to implement at schools and colleges.

Since some teachers (lecturers) are poor at planning, even when there is clarification for each level on how to use the content from curriculum documents, it does not mean they know how to use these methods and strategies (Esterhuyse, 2005:5-6). Hence, the lesson study process provides an incentive for teachers to develop their understanding of content in which teachers plan lessons together which could play a role in contributing to more effective lessons that include the basic content knowledge and appropriate methods or strategies for the clarification of content at every level.

According to Goldshaft (2016), lesson study is a classroom-based, collaborative, professional development model which focuses on student learning. The main component in lesson study is the research lesson which, according to Coe, Carl and Frick (2010:212), is developed collaboratively by the lesson study team to move the students closer to the predetermined goal.

Although different authors list different steps for LS, some by combining two steps and others dividing one step into two, the LS process, according to Bush (2009:6) and Coe, Carl and Frick (2010:211-213), consists of the following six steps:

- deciding collaboratively on the goal of the lesson;
- planning the lesson together which is called the research lesson;
- deliver and observe the lesson;

- review and discuss the research lesson (debriefing);
- revise and adjust the lesson; and
- share findings.

Each of these steps or phases is explained in detail in the literature chapter (chapter 2 of this study) and these are also the steps adopted in this study.

Some of the benefits of LS are that it encourages sharing knowledge in a collaborative manner, improvement in lesson planning and that it takes place in the context of the classroom (Stepanek et al., 2007). According to Esterhuyse (2015), it allows for lecturers to examine and reflect on their daily practice and gives them the opportunity to keep on learning. In this study it was envisaged that over and above the usual benefits mentioned by these authors, the benefits of the manager being a participant of the LS process and sharing decisions and solutions with the LS team would be how managers would use the process of LS at TVET colleges and what contributions they would make, being part of the LS team. It was also envisaged to integrate the LS participant model into the LS model.

1.2.2 Management's role: a brief overview

To initiate LS at TVET colleges, strong efficient and effective leadership with committed management is necessary. Strong leadership and management are also necessary to maintain LS throughout the year at TVET colleges. Utaminingsih, Murtono and Utomo (2017:260) contend that the commitment of the leadership ultimately determines the success of lesson study and the quality of the improvement in learning. The type of commitment required at schools and colleges for subjects which are underperformed in subjects such as Mathematics and ML, is consistency and visibility, and the outcomes should go beyond LS.

Thus far the literature has revealed that management and leadership play a big role in getting the process of LS off the ground, but that managers and leaders were not visible throughout the entire process. Much of the literature on LS relies on the 'knowledgeable

other', who is either an external subject matter expert or an educational expert, but not a manager and hardly known to the LS team.

The fact that the 'knowledgeable other' is not part of the usual LS team means that the managers and leaders of schools and colleges still work in isolation from their teachers or lecturers and this cannot bring any sustainable improvements at schools and colleges according to Rock (2017:5) for subjects such as ML where improvements are crucial. Unfortunately, there are too few studies which show how managers who become part of the LS process and who allow lecturers to become collaboratively involved through the LS participative management model, seen as a component of the participative decision-making (PDM) model in deciding how to improve performance in ML. Therefore, the purpose of this study is to determine how managers together with their LS teams perceive the use of LS in the teaching of space, shape and orientation and what contributions they can collaboratively make towards LS when teaming up participatively with the LS team.

Instructional leadership (IL) in terms of strong visibility of leaders, not just on campus grounds but also in the Mathematical Literacy classroom, manager as learner and leader of learning (Vale et al., 2010:49) and becoming involved with lecturers in their teams is strongly accentuated by Jaca (2013). Visibility of leaders and managers is also one of the dimensions of IL of Hallinger (2012) and one of the prominent models developed in this study, namely the LS participative management model. This model will be able to find answers as to how managers can use LS in their monitoring of teaching, what contributions managers can make in LS teams and mainly how the current LS model can be modified to include managers in the LS teams.

Literature around the theoretical underpinnings of lesson study differs among authors and researchers, but the most common theories referred to in the literature are those of communities of practice, Vygotsky's constructivism, situated learning, pedagogical content knowledge and action research.

The theoretical foundation on which the leadership and management part rests is the different leadership styles found in literature, the instructional leadership of Hallinger,

and participative management, which is a component of PDM. A full review is presented in chapter 2.

1.3 STATEMENT OF THE PROBLEM

Since the introduction of the new subject ML at schools and TVET colleges in 2007 there has been a great deal of interest from various corners to monitor and study how the students of this subject performed at these institutions and how this subject achieved the outcome envisaged for the subject. The results of ML at schools and TVET colleges are not what were intended and one finds that many students at TVET colleges struggle to obtain results higher than the minimum required pass percentage of 30%. Although the pass rate is not as poor as in Mathematics, it must be improved if further decline in performance is to be prevented, considering the warning sounded by the Umalusi report of 2016 that performance is on the decline. This is reflected in Table 1.1 above.

Although, as shown in Tables 1.3 and 1.4 that the topic space, shape and orientation cover roughly 20% of the syllabus which is equal in weight to the other topics in the syllabus, assessment of space, shape and orientation is not equally spread throughout the year. The problem is further exacerbated by the fact that students perform the worst in this section in examinations compared to the other topics as shown in Tables 1.5 and 1.6. Hence, it is the contention of the researcher that in order to improve the results in ML, it will help a great deal if a conscious effort is made to improve performance of students in space, shape and orientation through interventions in the way this topic is taught at TVET colleges.

Lesson study (LS), which is showing great promise around the world, is a model that has been practised in other countries to improve performance in Mathematics. According to Delisio (2008), interest in LS also started to increase after the poor performance of US students in the TIMSS study of 1999 was compared to students in Japan who consistently scored very high in those tests owing to the use of LS by Japanese students.

Various studies reported on the success of lesson study as observed and used by educators, but no study was based on how managers as members of a LS team with lecturers can harness the lesson study model to improve teaching Mathematical Literacy in TVET colleges. Lesson study can therefore be used as a model in this present study to determine how managers as members of a LS team *with* lecturers through equal participation can improve performance in space, shape and orientation in ML and thereby improve the performance of ML of Level 2 students at TVET colleges. Level 2 NCV students were specifically selected as they form the foundation for the later years.

The involvement of managers in the LS process thus far has been mostly as a knowledgeable other, which involved observing and giving guidance, but was not directly involved in the full term of the LS cycle. At other times LS had only been initiated by a manager and a member in the team was appointed to coordinate and oversee the team without fully participating in the process (Triwaranyu, 2007:59). The aim of this research is therefore to involve managers as team members directly in the LS process for the full LS cycle(s) where managers become part of the LS team and directly experience the lessons in the classroom at the same level as the lecturers, and become observers as well as delivering the research lessons. For the purposes of this study, the use of lesson study teaching/ monitoring of space, shape and orientation is used as a management strategy to improve the performance in Mathematical Literacy at Technical and Vocational Education and Training colleges. It is hoped that through the improvement gained by LS, the process can be rolled out at other campuses of the college and to other colleges.

1.4 THE RATIONALE AND PURPOSE OF THE STUDY

Most students who enter TVET colleges in the NC(V) curriculum do so because they did not perform well in the mainstream subjects at schools and most performed poorly, especially in the subject Mathematics. Although this study targets the Level 2 NC(V) students, as it is the foundation for later levels, it is hoped that the results of this study can be extended to Levels 3 and 4.

It is interesting to note in this regard that Esterhuyse (2015:1) accentuates the fact that in order to improve Grade 12 (equivalent to Level 4 in the NC(V) curriculum) Mathematics results, it is necessary to improve learners' mathematical performance in lower grades. In view of this, it is important that lecturers at TVET colleges place a greater focus on students at Level 2 ML (and Mathematics) so that misconceptions and errors in thinking at the lower levels can be properly addressed to ensure the progression to higher levels is done effectively. One very efficient way of doing this is through the process of LS.

As mentioned before, the topic in the Mathematical Literacy curriculum that students struggle with the most is space, shape and orientation. It has also been found that there are a number of misconceptions around this topic. Hence, it has been selected as the focus of this study because the performance in Mathematical Literacy will improve if much more attention is given to this section of the syllabus. Moreover, a summary (see Tables 1.3 and 1.4) of a random sample of data extracted by the researcher from just the September examination of Paper 2 for the Level 2 NC(V) students of 2015 and 2016 revealed that 80% of the sampled students scored less than 50%, while more than 50% scored between 0-29% or below 30% for the section of space, shape and orientation.

In view of the above data, this study seeks to find ways on how lesson study can serve as a management strategy to improve performance through understanding the topic of space, shape and orientation at TVET colleges. Since it is difficult to determine what misconceptions students have, and also the lack of knowledge and experience of lecturers to highlight those misconceptions through observation, using the LS approach, could greatly enhance the knowledge of how to observe and use this as a basis for developing and presenting powerful lessons for managers and teachers.

The aims of this study are therefore:

(a) To determine how managers can use lesson study in teaching space, shape and orientation in TVET colleges.

(b) To determine how managers perceive the use of lesson study in teaching space, shape and orientation.

(c) To determine what the managers' contributions are in lesson study when teaming up with lecturers in dealing with space, shape and orientation.

(d) To determine how the lesson study model can be modified to include managers in the lesson study team and the impact it has on the lesson study process.

1.5 THE RESEARCH QUESTIONS

Berg (2001:25) asserts that how a researcher conducts his or her research depends largely on what the research questions are and how they are formulated.

In view of the background above and the theoretical foundation, the researcher posed the following main research question:

How can lesson study as a management strategy improve performance in space, shape and orientation in Mathematical Literacy at Technical and Vocational Education and Training colleges?

The intended sub-questions are:

(a) How can managers use lesson study in the teaching of space, shape and orientation in TVET colleges?

(b) How do managers perceive the use of lesson study in the teaching of space, shape and orientation?

(c) What are the managers' contributions in lesson study when teaming up with lecturers in dealing with space, shape and orientation?

(d) How can the lesson study model be modified to include managers in the lesson study team and the impact it has on the lesson study process?

The issue of validity in this study was addressed by ensuring that multiple data sources (interviews, observations, lecturer notes and journals) were used so that triangulation of data can also be achieved.

Ethical clearance was granted from the university through which this study was done, and then from the Department of Higher Education and then from the Head of the TVET college where this study was conducted. The researcher then proceeded to seek permission from the lecturers and students and anonymity and confidentiality were ensured by protecting their identity.

1.6 ORGANISATION OF THE STUDY

The respective chapters cover the following aspects:

Chapter 1 (Introduction)

This chapter consists of a brief description of the background to the study, an introduction to the study, the problem statement, research questions and the aim and objectives of the study.

Chapter 2 (Literature review)

This chapter focuses mainly on the literature review and briefly covers the different learning styles, general errors and misconceptions in Mathematics and Mathematical Literacy and errors and misconceptions in space, shape and orientation. This chapter covers previous and current literature on lesson study, instructional leadership as well as a review of different research methods.

Chapter 3 (Theories underpinning the study)

This chapter deals with the theoretical framework underpinning the study in terms of literature used in chapter 2. It discusses the theory on which lesson study, instructional leadership and management is based and discusses issues of constructivism, pedagogy and participative management, among others.

Chapter 4 (**Research methodology**)

This chapter deals with the research methodology in terms of the research paradigm, research approach and the population and sample used in this study

Chapter 5 (Findings)

This chapter documents the findings of the research.

Chapter 6 (Discussions)

In this chapter, the findings are discussed by interpreting what was said and found and then giving meaning to it.

Chapter 7 (Conclusion and recommendations)

This chapter deals with the conclusions, recommendation, limitations and further possible research based on the findings of the research.

1.7 DEFINITION OF TERMS

Role

The position or purpose someone or something has in a situation or relationship (Cambridge Advanced Learner's Dictionary, 2003).

Management

Management, according to Donelly, Gibson & Ivancevich (1992), is the process of coordinating the activities of others to achieve results that cannot be achieved by one person alone. In this study it refers to the activities performed by Fundamental Heads/Program Heads and especially Education Specialists for Mathematical Literacy.

Mathematics

Mathematics is a group of related sciences, including algebra, geometry and calculus, which use specialised notations to study numbers, quantity, shape and space or is defined as numerical calculations involved in the solution of a problem (Sinclair, 2001; Collins English Dictionary).

Mathematical Literacy

Mathematical Literacy provides learners with an awareness and understanding of the role that Mathematics plays in the modern world. Mathematical Literacy is a subject driven by life-related applications of Mathematics. It enables learners to develop the ability and confidence to think numerically and spatially in order to interpret and critically analyse everyday situations and to solve problems (DoE, 2003).

Misconceptions

The Cambridge Advanced Learner's Dictionary, 2003 defines misconception as an idea which is erroneous because it is based on a failure to understand a situation. In terms of Mathematics, misconceptions are stumbling blocks to the understanding of mathematical concepts. In this study the misconceptions students have around perimeter, area and volume will be investigated.

Perimeter

A perimeter is understood to be the distance around a two-dimensional shape.

Area

In the most basic terms, the area is the amount of surface covered by a two-dimensional shape.

Volume

Volume is the amount of space occupied by an object.

TVET College

The former FET colleges were renamed TVET colleges. A TVET college is an education institution where the TVET qualification is offered, mainly to young people between the ages of 15 and 19. These colleges also offer many support services as well as a diversified mix of qualifications to allow the young to take full advantage of their future possibilities.

Lesson Study

Lesson study is a classroom based, collaborative professional development model which focuses on student learning. As a process it consists of planning, teaching, observing, revising and re-teaching lessons in a classroom context (Coe, Carl & Frick, 2010:22).

Participative decision making

Participative decision making is defined as a mode of organisational operations in which decisions on activities are arrived at by those various persons who are to execute these decisions (Rock, 2017:4 & 7). In terms of this study, it is the collective decisions made by the LS team in collaboration with one another.

Participative management

Participative management takes place when management and employees are jointly involved in making decisions on matters of mutual interest where the aim is to produce solutions to the problems which will benefit all concerned (Buthelezi, 2016:8).

1.8 CONCLUSION

This introductory chapter sets the foundation of the study. It discusses the background to the study in terms of the introduction of Mathematical Literacy into TVET colleges and the concern of its performance, the problem statement, and the rationale of the study. The chapter then makes the reader aware of the research questions which are posed, after which the limitations of the study are discussed. Lastly an outline of the rest of the chapters is given.

The next chapter discusses what other researchers mention about lesson study, misconceptions in space, shape and orientation and instructional leadership. The chapter continues on what theories underpin lesson study and instructional leadership.

CHAPTER 2
LITERATURE REVIEW

2.1 INTRODUCTION

This literature review focuses on Lesson Study (LS) and how LS can assist as a management strategy in improving performance in Mathematical Literacy at TVET colleges. Although the primary goal of this study is to investigate the use of LS to improve performance in Mathematical Literacy at TVET colleges and how it can assist managers at TVET colleges, it is driven through the use of areas in management and leadership, such as participative management, transformational leadership and instructional leadership as vehicles and inquiries to explain, connect and understand it better. Although the goals of LS do not explicitly include areas of management, this line of inquiry in this study was a beneficial and fruitful one.

This chapter begins with a brief purpose of the literature review after which it discusses LS in terms of its history, research themes regarding LS, the steps or phases of LS and finally, the benefits and some disadvantages of LS. The overall poor performance of Mathematics is discussed and the reason for introducing ML in South Africa, the current state of Mathematics and ML and the management of ML at schools and TVET colleges. The chapter then proceeds to discuss areas of management and how LS can assist managers through participative management and transformational management. Before this is done the concept of leadership and some of the different leadership styles found in the literature are discussed.

2.2 BACKGROUND

Singh (2006:36) says with regard to literature review, “The literature in any field forms the foundation upon which all future work is built. If we fail to build the foundation of knowledge provided by the review of literature, our work is likely to be shallow and naive and will often duplicate work that has already been done better by someone else.” This means that any future findings in a field of research must have a frame of reference on

which it is based. Furthermore, researchers must be clear in their research that they are not copying work that has already been done.

According to Creswell (2014:60), the literature review accomplishes several purposes, one of which is to share with the reader what other studies have already been done which are closely related to the one being investigated. Another purpose is to fill in gaps and expand prior studies. In this particular study, literature was specifically reviewed with a view to filling in gaps how managers of ML can use LS as a management strategy to improve the overall performance of the subject as well as what contributions managers can make to the LS process.

According to Singh (2006:36), the review of literature is essential for the following reasons. Firstly, it provides a review of research done previously in order to direct the researcher in his/her research by referring to the quantitative and qualitative approaches used. Secondly, it is essential for investigators to be up-to-date in their information about the literature related to their own problem already done by others. It is considered the most important prerequisite to actual planning and conducting the study. Thirdly, it avoids the replication of the study of findings to take an advantage from similar or related literature as regards methodology, techniques of data collection, procedure adopted and conclusions drawn. Consequently, the purpose of this literature review is therefore to get the views of other authors on the topic under discussion, which is to investigate how lesson study as a management strategy can improve performance in space, shape and orientation in Mathematical Literacy at a TVET college. In the next section the researcher discusses/ presents the overall performance of students in Mathematics and ML.

2.2.1 Overall poor performance in Mathematics and ML

Over the years the subject Mathematics has received much attention in terms of students' poor performance as well as the interventions that were conducted to improve performance. In fact, it is true that Mathematics received much more attention than any other subject at schools, colleges and universities. It has also been the subject that has been debated at the highest government level and continues to receive the highest

attention. The reason is that it determines success of schools and governments and it is also used as a criterion to indicate the state of a nation. It is also true that many learners from Grade 9 onwards drop Mathematics, because some of them find it difficult to cope with. This results in many learners entering real life without a mathematical background.

In order to address the above situation, the government decided to introduce Mathematical Literacy at schools in 2006 and at the former FET colleges in 2007. South Africa was the first and only country in the world to have Mathematical Literacy as a subject at schools and the former FET colleges (Botha, 2011:1). Mathematical Literacy is compulsory for learners not taking pure Mathematics (Owusu-Mensa, 2013:3). This gives learners who performed very poorly in Mathematics an opportunity to at least do some Mathematics which they can apply before they drop Mathematics altogether and remain innumerate.

However, the concerning part is that more schools are now also dropping Mathematics as a subject from their programs and replacing it with ML in order to increase the overall matric pass rate at their schools, according to Nkosi (2014). Nationally, the problem is compounded by the fact that enrolments for Mathematics plummeted from 263 000 in 2010 to a little more than half in 2014 and are still dwindling according to the same report. For example, in the 2013 matric examination, more than 280 000 learners wrote Mathematical Literacy and 87% passed. By contrast, only 143 000 wrote Mathematics, of whom a mere 60% passed. This trend has continued according to Pijoos (2020) and at the end of 2019, when Umalusi announced the matric results, it repeated the announcement of the concern about Mathematics marks, the dwindling numbers of students taking Mathematics and the increase in ML numbers. Umalusi suggested that the subject Mathematics has to be taught differently. Also, at TVET colleges, in the NC(V) curriculum, more students are taking ML. This is because more programs at TVET colleges in the NC(V) program require ML instead of Mathematics. Hence, the researcher is of the opinion that more emphasis should be placed on ML to raise its profile in terms of quality and improvements so that more students achieve pass percentages above 80%.

TVET colleges (previously known as FET colleges) were the former technical colleges which merged to become TVET colleges. There are currently 50 TVET colleges and roughly 300 campuses nationwide, but increasing as more TVET colleges are being built. The subject Mathematical Literacy (ML) was introduced in SA in 2006 at schools and at TVET colleges in 2007 to ensure that all citizens completing their education enter the working world with knowledge of some form of mathematics which they can use in real life and so remain numerate. Although it was considered an 'easier' subject, performance of this subject was also below par as the Umalusi reports of 2016 and 2017 show. Although more students are offering this subject at schools and TVET colleges and more are passing, it does not mean they are performing well in the subject. Performance in this subject is also on the decline as many students are struggling to pass in the 70 – 100% category. (See tables in chapter 1).

The Department of Basic Education's announcement of 20% Mathematics pass mark owing to a large number of learners who pass all subjects, except Mathematics, is a grave concern for the future of mathematically related subjects (TIMSS report, 2015). Mathematics has also been used as a gateway and gatekeeper to determine whether students would be successful at universities and TVET colleges. From a teaching perspective, Mathematics is also one of the most challenging subjects for teachers to teach and for learners to learn at schools and TVET colleges. To assist in improving the performances in this subject, various strategies and interventions are employed to deliver the subject. From a pedagogical viewpoint, educators must not only know the content well, but they must possess correct techniques in delivering the subject as well as knowledge about learners, how they think and learn.

From the perspective of managing ML, the researcher's view is that it is not only lecturers of the subject that must have adequate knowledge of all the curriculum documents, policies, processes and procedures related to the subject of Mathematical Literacy, but also the immediate managers of the subject such as fundamental heads, education specialists and to a lesser degree campus heads at campuses where the subject is offered. The immediate managers are the managers and the implementers of

the subject; their interaction with the subject should be of paramount importance. Hence, they must be able to lead the implementation process and empower lecturers in terms of resources and support and motivate them to improve their understanding of the subject and its overall results. According to Lee (2012), Smith (2008) and Jaca (2013), learners' performance improves and teachers' teaching is enhanced where managers are part of the instructional process. This is true for LS and any processes where new systems and processes are implemented.

LS provides a powerful way for lecturers and managers of ML to come together as a team and collaborate in a participative group and focus their attention on the content of ML, also on the delivery of the subject at a high level. The involvement of managers and leaders in the specific content of ML is also strongly supported by Jaca (2013) who suggests that instructional leaders improve their content knowledge, become involved with lecturers in leading by example through presenting lessons and making learners their first priority. The implication of this is that managers must be at ground level, visible and taking a leading role with lecturers and students of ML. This is also the main objective of this study, namely to get managers involved, fully or as participant observers, in the LS team and the process of LS. Lesson study has all the elements of improvement in IL, participative management involvement, content knowledge and numerous other improvements as suggested by Jaca (2013).

Only a few countries have performed exceptionally well in Mathematics. They are Singapore, Hong Kong, Korea, Chinese Taipei, and Japan who continues to dominate the ranking of TIMSS according to the report by Anderson (2016). According to the TIMSS report of 2015, South Africa performed extremely poorly, compared to other countries. In fact, it was placed 38th out of 39 countries for Grade 9. Mathematics has also shown poor performance at schools, TVET colleges and universities.

Various reasons may be advanced why students perform poorly in Mathematics and ML and many debates are conducted at local and national levels as to why students perform poorly. The reasons for poor performances range from students having anxiety and fear for Mathematics and inadequately qualified Mathematics teachers who are not innovative enough (Jameel & Ali, 2016:133). Other studies conducted in Nigeria (Sa'ad,

Adamu & Sadiq, 2014:32; Yussuf & Hammed, 2019:19) concluded that students' negative attitude toward Mathematics, anxiety and fear of Mathematics, inadequately qualified teachers, poor teaching methods, inadequate teaching materials and overcrowded classes were some of the causes of poor performance in Mathematics in the study area. Studies conducted in SA do not differ much from what was found in other countries. For example, a study conducted in South Africa cites inadequate preparations at the foundational level, teachers' lack of content knowledge and lack of creativity (Sinyosi, 2015:65-69). The lack of principal and management support are also reasons for poor performances in Mathematics. Management support through managers becoming involved in the subject ML through the process of LS with lecturers is what this study hopes to achieve.

2.2.2 The NC(V) Mathematical Literacy curriculum at TVET colleges

Since this research concentrates on ML, the researcher refers mostly to ML although in certain cases reference is made to Mathematics. Through the analysis of results, examination scripts, experiences in classrooms as well as talking to lecturers and educational specialists from other TVET colleges at provincial memo discussions and panel discussions, the researcher has realised that the topic of space, shape and orientation is a challenge for most students and for both Mathematics and ML students. This is also a challenge at both schools and TVET colleges.

The National Curriculum Vocational (NC(V) ML curriculum consists of five topics. Each of these five topics occupies exactly 20% of the curriculum (DHET Subject Guidelines NC(V) 2013). Hence, the topic of space, shape and orientation also occupies 20% of the curriculum. Comparing the results of the different sections of students' scripts, it was clear that students perform the worst in the topic of space shape and orientation in ML. The researcher therefore argues that improving the teaching and learning of this section through focusing our attention on ways to find intervention strategies can gradually improve the overall results of students at TVET colleges. The researcher further argues that using the lesson study method can greatly enhance performance in the same way it was found at schools in Japan where LS was implemented.

Among the major reasons why students struggle with the topic of space, shape and orientation, of which a large part covers perimeter, area, volume and related contextual problems, are misconceptions or errors which occur in learners' minds, sometimes as they learn and at other times when answering questions in examinations. For example, according to Berenger (2010:27), students confuse perimeter with area, thinking that it is the same concept and not understanding that they are different. Other misconceptions in the area of space, shape and orientation are that mathematical rules for calculating perimeter, area and volume and their units become confused. They often believe that rulers can be used to measure area.

One of the reasons why misconceptions occur is that lecturers do not spend enough time observing how students are learning these concepts. This is due to the pressure of completing a syllabus and that lecturers do not have the necessary skills in observing students. If they do observe, what must they do with these observations? If lecturers spend enough time on checking how students learn these concepts by observing them in class while they are busy, it can immediately be corrected to prevent further mistakes. How managers use this information and how they contribute to improve instruction and performance is of concern to this study. For example, many students think that a rectangle has to have two long sides and two short sides (Utah Standards Academy, 2014:12). This can become a problem later when different shapes must be identified. The observation phase of LS deals with providing lecturers with enough skills to check how students are performing while they are in class.

After the TIMSS study of 1999, interest in LS started to increase when the poor performance of US students was compared to students in Japan, who consistently scored very high in those tests. The possible reason advanced for their high scores was attributed to the practice of LS as it was used in Japan (Delisio, 2008:2-3). When educators in Japan saw how LS improved their teaching and students' learning, they wanted to use it on a regular basis. It is hoped that through LS and the subsequent findings of this study it will also enhance and improve lecturers' practice in ML at TVET colleges. In the words of Dr Yoshida, "In education we want students to be life-long learners, so we should expect the same from educators" (Delisio 2008:3). Hence,

educators should from time to time also improve their practice. One method of improving their practice is the work-embedded process of LS. Knowledge of misconceptions can enhance and assist lecturers in developing effective lesson plans precisely to address these misconceptions, even before they take shape. LS, which takes into consideration how students learn, can become a valuable tool and method to address this issue through developing powerful lessons through collaborative practice and observing how students perform.

Berenger (2010) points out that we need to know what students continuously do incorrectly and why. According to Berenger (2010), we need to know what students are thinking or were thinking when those mistakes were made and to find ways to identify those common misconceptions. For example, there is a strong possibility that the LS phases can assist a great deal to zone into how students think and identify these misconceptions and immediately go into action to minimise them through adapted and more effective lesson plans.

There is a possibility that LS can be very effective in identifying misconceptions as this can assist in lecturers spending more time in planning their lessons effectively in order to address this crucial part of the curriculum if lecturers know beforehand what these misconceptions are. The component of pedagogical content knowledge (referred to below) known as knowledge of students' cognition can greatly assist in this regard. Many reforms to improve the performance in Mathematics/ Mathematical Literacy have been put in place in South Africa and around the world. Some of them have been successful to some extent and others have not had the desired outcomes; it has been unsuccessful or had minimal effect owing to the absence of leadership and management.

In many studies, LS had been used as an intervention method to improve performance in Mathematics through the improvement in students' performance as well as improvement in teachers' class performance, using it as a form of professional development (PD). However, it is hoped that LS can be successfully implemented if it is backed and sustained by management and in this study the manager becomes involved by being a non-participant observer in the LS process. It is hoped that through this study

managers will be able to use LS in their TVET colleges as well as make contributions when teaming up with lecturers at their respective campuses and colleges.

2.3 LESSON STUDY

Lee (2012:32) mentions that lesson study is a method implemented by Japanese educators as a way to reform educational practices. It is known as *"jugyou kenkyuu"* in Japanese, and it describes the 'continuous process of school-based professional development' (Stigler & Hiebert, 1999:110) within a structure that facilitates the transmission, formation, reformation and reflection of lessons and instructional practices through collaboration (Marble, 2007:937). In the context of LS, the transmission happens through collaboration with other teachers whereby knowledge is transferred and shared by and with other teachers, resulting in the formation and reformation of concepts and ideas. The observation process in LS allows teachers, by observing fellow teachers and students, to reflect and review lessons. Through the observation process it is expected that lecturers would place more emphasis on the reflection of their lessons and thus use this information as ongoing improvement for their lessons.

Lesson study is a teacher-based and teacher-driven activity focused on student learning that requires a long-term commitment to the process. It is teacher (lecturer) -based since it involves a group of teachers (lecturers) working together collaboratively in all the phases of the LS process from deciding on the goal of the lesson through observing the students to debriefing the lesson and re-teaching it. It is also driven by teachers and managers in the sense that it requires much commitment from both teachers and managers to see the process through to its final destination.

The aim of most studies conducted in LS has been to improve student performance, but also to improve teaching at education institutions. As a form of Continuous Professional Development (CPD), LS has been used to provide an alternative form of professional development for educators in a non-traditional manner by focusing attention in the classroom as on-the-job professional development. This study, however, takes it a level further by investigating how managers can benefit by LS and also investigates what contributions managers can make through the use of LS at their respective institutions by being a non-participative observer.

According to studies conducted (Coe, 2010; Lee, 2012; Goldshaft, 2016), lesson study has proved to be very successful as a PD model in terms of improvement, both in the teacher's ability and in learners' performance in the countries where it has been implemented. Japan is one such country where it was successfully implemented and is still used on a large scale in many subjects. Lesson study done in Japan is also used as a benchmark by which the success of other lesson study research is being judged. According to the researcher's knowledge, there is only a limited number of studies linking LS with management. There are also no studies which have investigated LS as a management strategy. Hence, it is hoped that this study may assist managers in using LS as a strategy in teaching and learning at their institutions and thereby expect to improve their institutions.

2.3.1 What is lesson study?

Goldshaft (2016:2) asserts that lesson study is a classroom-based, collaborative professional development model which focuses on student learning. As a process it consists of planning, teaching, observing, revising, reflecting and re-teaching lessons in a classroom context (Coe, 2010:22). The process commences with deciding on a goal on which area to focus on in a topic of a subject, and gradually developing it into a first research lesson which is the result of the participant's collaboration of various inputs. Through the delivery and observation of the lesson it evolves into a reviewed and revised research lesson using the observation and reflections from participants as input until an ideal lesson is achieved for the particular focus. According to Bush (2009:4), it consists of a detailed study of the practice of teaching and is built on the premise that the best way to improve education is to get teachers together to focus on the processes of teaching and learning and then to find ways to improve them.

The processes of teaching and learning which unfolds in a classroom context and which are also present in LS but are more pronounced: deciding on a goal, planning the lesson, reflecting on the lesson and assessments. In LS these same processes are done collaboratively and more attention is placed on planning the lesson, debriefing the lesson, observing students and revising the lesson for re-teaching the lesson for a second time.

2.3.2 Initiating LS at TVET colleges

Before the planning phase commences, it is important to get all lecturers involved who teach the subject ML at the campus of the TVET College and have a passion for the area that needs attention. This was done by getting their buy-in to participate. Usually, a leader who is a senior among the lecturers is selected to drive the process. In this study the researcher who is an educational specialist was the driver of the process. Next a research theme or over-arching goal is decided on by the team. In this study the research theme was how to use LS as a management strategy to improve performance in ML by focusing on space, shape and orientation.

2.3.3 The lesson study steps

Stols and Ono (2016) document various LS approaches. For example, they refer to their approach as 'plan – teach – reflect'. In essence, according to these authors, lesson study entails the following steps: (i) Planning a lesson as a group, (ii) One team member teaching the lesson while the rest of the team members observe students, and (iii) Post-lesson discussion (reflection session) and improvement of the lesson.

As a guide the number of steps or phases in the LS process differs from author to author, according to Esterhuyse (2015) and Coe (2010), while some have adapted the LS process to suit their study under discussion. For the present study, the researcher finds the steps advanced by Bush (2009) suitable and appropriate for this study as they involve all the necessary steps of the LS process.

According to Bush (2009:6), the LS process consists of the following 6 steps or phases:

Phase 1: Agreement on the focus or goal of the LS

When the LS group gets together in its first few meetings, the participants discuss and agree on a focus or goal by deciding on a research theme. This may be anything from school-based or content-based, or a Mathematical Literacy topic such as space and shape and orientation, as was chosen for this current study. Lewis (2002:2) advises selecting an academic focus on a section of a topic that is persistently difficult for

students and presents a challenge for lecturers to deliver effectively. In this study the topic of space, shape and orientation was selected as the LS team unanimously agreed that this was an area that most students struggle with. Every participant must agree with the others that the area chosen is challenging to them to teach and it must be based on evidence. The evidence for this study came from memo discussions, examination scripts and Focus Group (FG) discussions.

The Focus Group consists of 8 TVET colleges, 6 in the Western Cape and 2 who joined the Focus Group recently from the Northern Cape. This FG, which is initiated by the Department of Higher Education (DHET) meets at least twice a year in which representatives of each college review the ML curriculum, plan the curriculum for the next year, review assessments for the current year, design standardised and common assessments for ML for the 8 TVET colleges and assist in audits of TVET colleges. The entire process is directed and coordinated by the regional FG coordinator; a position held by the researcher since 2019. It is hoped that through the research lesson as well as the observation of case students, lecturers will improve on their delivery and observe what students do incorrectly in the topic space, shape and orientation.

Phase 2: Planning the research lesson together

According to Dudley (2014:6), it is important to choose the lesson study team properly and he advises that a group of three lecturers works well. Dudley (2014:6) further advises that there should also be a mix of teaching experience in the team. In this phase the team work collaboratively to design its first research lesson. This is the lesson that is taught and attempts to address the goal in phase 1. An existing lesson may be used, but it has to be adapted to suit the goal of the research lesson study. Furthermore, the research lesson must be carefully designed in terms of sequence, intended learner activity and anticipated student responses (Dudley, 2014:8; Bush 2009:6). This phase should encompass several weeks and days of a series of discussions where the participants get together and plan the research lesson. It entails discussing the different parts and sections of a lesson plan, how it will be introduced, which problem-solving approach or student-centred approach, if any, will be used, which activities will be discussed and the intended and anticipated student response are

discussed. Every participant is expected to give his/her input and everyone will be fully informed of the contents of this first research lesson. The case students (those students who will be observed) form the background around which the lesson is designed. The final research lesson(s) for this research is attached in the appendices.

According to Bush (2009:8) and Dudley (2014:8) the following is worthwhile bearing in mind when designing one's own research lesson:

- Agree on a particular class
- Plan every stage of the lesson
- Identify some 'case students' preferably no fewer than three and agree on which 'case students' a lecturer will focus on in his or her observation.

Phase 3: Deliver and observe the lesson

The lesson is delivered by one of the LS members who is selected and observed by the others. The most important instruction that the LS group members must understand about this phase is that the focus is on student's learning and not on teachers teaching (Dudley, 2014:9). Hence, the observers must observe the students and what they are doing (or not doing) and how they are doing it, as well as their behaviours, self-talk and discussions in their respective groups. Regarding this, Burghess and Robinson (2010:9) further strongly point out that the focus of the observation is on the students' thinking and responses rather than on the teacher's ability. Bush (2009:9) mentions that observers should try to capture student responses at different points of the lesson and document it in their own journals by making notes on how it deviates from what was predicted. This phase must be thoroughly planned by the facilitator who, in the present case, is the researcher as manager in terms of resources, arranging which class must be used according to the timetable, making sure it was communicated to all affected parties and ensuring that all participants have a copy of the current first research lesson and the correct observation sheet to enter their observations into their journals. This must be done a day or two before the time to be effective.

Phase 4: Review and discussion of the research lesson

Burgess and Robinson (2010:9), Bush (2009:10) and Dudley (2014:11) all agree that the group meets on the same day on which the research lesson was delivered and not more than 24 hours after the lesson. This is to ensure that what was observed is fresh in the lecturer's and observers' minds. It is a good idea and advisable to start with the lecturer who delivered the lesson and noting his or her impressions on what went well or not. Bush (2009:10) advises to chair the discussion and another to document what is said. In this study the discussion was chaired by the researcher. All the members of the LS group should contribute to this discussion. If case students were used it would be a good idea to record their responses, actions and behaviour. It is also advisable to interview case and other students and to record responses as well as the proceedings of the debriefing session. The observation sheets as well as students' answer scripts should also be used as input into the next phase in revising the lesson. This procedure was also followed by the researcher in the present study.

Phase 5: Revise and adjust the lesson

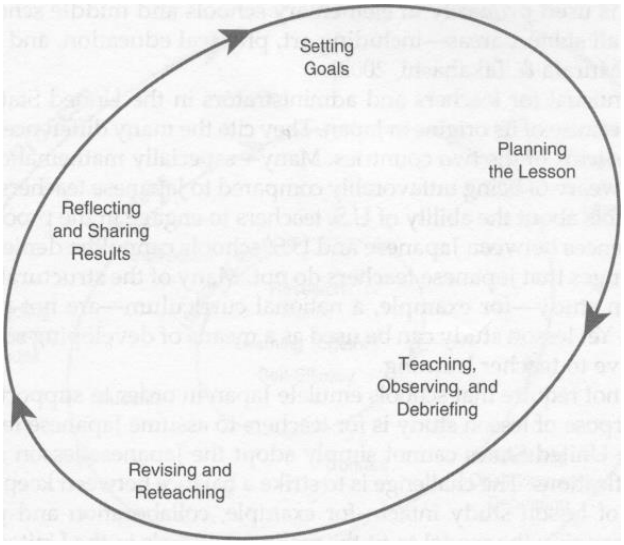
The discussion above results in group members agreeing on what needs to be refined or adjusted to bring about a new revised and improved lesson. This should also be done over a few sessions in order to improve the lesson and all input of the participants should be taken into consideration. The revised lesson is then delivered to a different class by a different member of the group and again observed by the non-teaching members. This new lesson is also reviewed and delivered again for a next cycle of LS.

Phase 6: Share findings with others

In this last phase opportunities should be identified by the LS group, while at the same time senior managers should make opportunities available for the group to share their findings and what they have learned with staff at bigger meetings. This is one way for the LS group to showcase their findings and experiences. The LS process can then also be taught to other members of the staff to be applied to their subjects for them to improve their pedagogy. The idea is to get the entire college involved in LS and not just in one subject, department or campus and then cascading it to the entire TVET sector.

A diagram depicting the LS process as taken from Stepanek, Appel, Leong, Mangan and Mitchell (2007) is shown below.

The Lesson Study Process



Taken from Stepanek et al., 2007

2.3.4 Lesson study as a professional development tool

As far as Continuous Professional Development (CPD) is concerned, most CPD programs are conducted outside education institutions by 'experts' who are not connected to the institutions and far removed from where the action takes place. Hence, this is not effective as it has to be context relevant as the needs of each institution are different. McDonald (2009:38) mentions that the traditional one-day or weeklong professional development outside school is no longer effective and is not appropriate for teacher change. One way of providing high-quality professional development to increase teaching capacity is through a collaborative lesson study process, gradually and incrementally improving pedagogy (McDonald, 2009:ii; Lee, 2012:30). CPD through the use of LS makes it context-driven as it happens in class and is job-embedded and where the action is, by people who are the best suited to know the context in terms of the environment, culture of the organisation and knowledge of their students. Teachers are provided with on-site, on-going and reflective practice based on the classroom

environment (McDonald, 2009: ii). Ono and Ferreira (2010:61-62) refer to the professional development which results through LS as alternative PD.

The main component in lesson study is the research lesson which, according to Coe, Carl and Frick (2010:212), is developed collaboratively by the lesson study team to move the students closer to the goal which was decided on by the lesson study team. The study supports the claim that LS affords a shift from how teachers (lecturers) teach to how learners (and teachers/ lecturers) learn. The study also finds that the LS model requires strong support from school leadership to achieve sustainability (Goldshaft, 2016) and this is also the thread that runs through many other studies. Without management and leadership's buy-in, LS might fail. In the current study the main difference was that the managers were non-participative members of the LS teams.

The majority of studies reviewed on lesson study focus mostly on lesson study as a tool and model for professional development of teachers at schools and the fostering of social collaboration among teachers through working together. The team approach in LS and applying and implementing it at every stage of the LS process and repeating the stages in the next few cycles, result in improved pedagogical knowledge in teaching and learning the subject Mathematical Literacy (McDonald, 2009; Goldshaft, 2016; Stewart & Brendefur, 2005; Shúilleabháin, 2015). Being together in a team instead of being alone gives group members the feeling that they belong and gives them an opportunity to be among like-minded colleagues with similar interests, resulting in growth and development. Other studies concentrated on the impact LS had on teachers' teaching and their perspectives on it (Wright, 2009:100-105). In this study teachers believed that their Mathematics content knowledge was positively affected in the areas of deeper understanding which led to an increase in self-confidence. It further led to improvements in the areas of planning and attention to student thinking.

Further research by Lee (2012) shows that lesson study can also be used successfully as an improvement strategy at low performing and at-risk schools. The study by Lee (2012) in which a particular school had chronic low performance in languages and was at risk of being closed followed a program of a turnaround reform strategy at this school.

This turnaround intervention, making use of LS, resulted in teachers reporting an increase in their instructional skills in terms of focused planning and attention to student learning. Teachers also found that the lesson study process increased their motivation and confidence as educators. In times of curriculum change LS has also shown to be an aid in facilitating and implementing the changes as reflected by Shúilleabháin (2015:34) when investigating the impact lesson study had at the crucial time of curriculum reform in South Africa. Furthermore, in engaging with the processes of lesson study, teachers became more comfortable in incorporating sociocultural practices within their teaching by planning and reflecting on whole class discussions, in facilitating student group work and engaging in problem-solving practices during research lessons as the current study has also shown.

LS indicates great promise as a model which can be used for subjects at risk such as Mathematics, science and some languages. This is because it can be applied to mathematical subjects in general, but it can also be used to focus attention on certain topics and content that teachers either find challenging to teach or learners find difficult to learn. An example of such studies is the one conducted by Hebe (2015) which focused on a certain part or section of Mathematics. In this study by Hebe (2015) which focused on multi-digit subtraction, showed that focusing on a certain area of the work where students struggled and where there were challenges, solutions were found which were used in the researcher's future work. Another study by Shúilleabháin (2015) which concentrated on the Pythagoras theorem, all teachers reported improved understanding of facilitating group work through incorporating more communication in Mathematics classrooms. Teachers also reported that their subject knowledge around the Pythagoras theorem improved (Shúilleabháin, 2015:24) and this had a positive impact on their pedagogy.

A positive influence was also experienced by the teachers on planning, observing and motivating teachers to participate in LS owing to the support of management (principals and middle managers) (Shúilleabháin, 2015:31). This shows that LS may be employed very successfully if only a certain part or section of a subject is focused on for study in a

LS process, at the same time improving motivation to participate and PD. Hence, the present study focused on the topic space, shape and orientation and how managers, being part of the LS process, as participant observers can assist in how it may be used and what contributions they could make.

As far as South Africa is concerned, the researcher has not found any studies conducted on LS at TVET colleges, not to mention on the topic space, shape and orientation in South Africa. In fact, the most common type of lesson study is school-based (Watanabe, 2002:36). However, a study the researcher read about was conducted at an education college and it dealt with a curriculum specialisation course in Mathematics education using LS with pre-service teachers (Carrol, 2013). The researcher could also not find any studies conducted using LS in ML. The researcher is of the opinion that this is an area that needs to be probed and investigated as it can be implemented very successfully in finding deeper understanding of some topics such as space, shape and orientation in Mathematical Literacy. Briefly, the topic of space, shape and orientation at schools and TVET colleges entails calculations with perimeters, areas, volumes, map work, floor plans and 2D together with 3D scale drawing. Lecturers usually experience challenges in teaching this topic in ML and Mathematics. The researcher thought of LS as one of the models which may be explored where managers not only support teachers but also get directly involved to experience classroom practice that enhances the learning of space, shape and orientation.

There are also few studies which connect LS with the effect it has on management and how LS can be used as a management strategy in improving performance of ML at education institutions and less so at TVET colleges. Very few studies have been done to show how managers can make a contribution to the LS process. The only studies the researcher has read about are those by Farhoush, Majedi and Behrangi (2017), Kuramoto and Shi (2012) and Smith (2008). Kuramoto and Shi (2012) investigated the relationship between LS and broad aspects of curriculum management, while Farhoush, Majedi and Behrangi (2017) devoted their study to education management and LS.

A final study which the researcher would like to mention is the one by Smith (2008). Although the focus of the study by Smith (2008) is not on management *per se*, but on empowerment of lecturers through the LS process, many lessons can be learnt from this study, especially how lecturers, but also managers, can empower themselves and their institutions. This empowerment results by using the context-driven supports and enabling factors of personal and professional benefits referred to by Smith (2008). Some of these supports, enabling factors and benefits are: improvement, democratic participation, social justice, capacity building and organisational learning. Through leadership and management, the total sum of those benefits can result in whole institution improvement and hence improvement in organisational culture.

Many studies (Jaca, 2013; Jita, 2010) reported that there is a dire need for leadership and management to become involved with lecturers in their classrooms and to become more visible in the eyes of the students. LS provides a perfect and powerful opportunity for leaders and management to become involved with lecturers in all the processes and stages of LS. When managers become involved in the planning and observation phases, they become so much more powerful. Management and leadership are not just necessary in getting LS off the ground, but also to become part of the entire process as the experience they can bring to the table may be extremely valuable. The education management model referred to by Farhoush, Majedi and Behrangi (2017) which consists of applying LS to Mathematics teaching, seems to be a step in the right direction. That study indicates that applying an educational management model combined with LS in teaching Mathematics produced better results than without LS.

Some LS approaches which have been effectively used in Mathematics relate to a study by Paulsen (n.d.:11) where the approach was to use LS by first assessing teachers' content knowledge of decimal fractions. Teachers' lack of this content knowledge was used as a starting point in the planning phase of LS. This study was effective in the sense that teachers improved their teaching in their Mathematics classrooms; the use of group work in Mathematics teaching improved both teachers' as well as students' learning. Another successful approach was used by Corcoran (n.d.) where problem

solving was used by a LS group study with primary Mathematics concentrating on students' thinking. This was done by allowing students to communicate their expression of ideas while engaging in problem solving which resulted in the enhancement of Mathematics teaching and learning among student teachers. Similar research using the problem-solving approach in Mathematics with LS was conducted by McDonald (2009:5) which showed great success as a tool for professional development of teachers.

Another area where LS was used very successfully was in a study by Fernandez (2005) in reforming the teaching of Mathematics by transforming teacher-centred teaching to student-centred teaching. This study resulted in using the revised lesson of a LS cycle to improve the understanding of polyhedrons by experimenting with various polyhedrons and hence deriving their own formulae.

In this study, the researcher adopted and modified the LS process to make the visibility of managers prominent by their becoming participant observers in the process in the sense that managers become participant observers at every stage for the entire process. This modification resulted in the researcher's developing the participative LS model. It further enabled the researcher to collect information on how the manager can use the process of LS at TVET colleges, what contributions they can make to the LS process and the contributions they can make to improve the performance in ML.

2.4 BENEFITS OF LS

Literature indicates various benefits that LS provides such as collaborative benefits, benefits to lecturers and colleges, to teaching and learning, organisational benefits and benefits to managers. This study focuses on the benefits of LS when managers participate with lecturers at TVET colleges.

2.4.1 Benefits of lesson study through collaboration

According to Lee (2012:23-24), building capacity in lecturer's knowledge and incorporating collaborative opportunities, lecturers not only grow as professionals, but it

also increases their interest and role in a learning community encompassing their colleagues. This inevitably impacts positively on student achievement and performance. This same study (Lee, 2012: 24) reports that when PD is connected with classroom and curriculum and is *collaborative*; instructional practices change and student achievement increases. Nash and Huffman (2014:1), when summarising the work done by Schmoker's Results Now (2006), refer to fundamental concepts for effective professional learning communities as: common curricular standards; regular meeting times to discuss curricular issues; reflecting regularly on students' work and refining and guiding teaching. For this to be successful, active collective engagement and collective participation is necessary by all participants in the process. All these concepts are present in LS as well.

Collaborative sessions involving teachers collectively participating and collaboratively designing lessons, implementing those strategies and reflecting on teaching practices and students' performances, improves teaching practices and improves students' performance. It also builds capacity in terms of knowledge, skills and dispositions such as shared goals and visions and a culture of collaboration that brings about organisational improvements. It further motivates and builds confidence and self-image in participants.

2.4.2 Other benefits of Lesson Study

LS is a collaborative procedure that can be used to afford Mathematical Literacy lecturers with an opportunity to work together and share knowledge and experience. According to Stepanek et al. (2007), some of the benefits of LS may be listed as follows:

- It results in the generation and sharing of knowledge
- It improves lesson planning as it is done collaboratively by several persons
- It is focused on student outcomes
- It is classroom-based and happens within the classroom context to determine direct evidence of its effectiveness of specific strategies, unlike the case with professional development workshops which happen outside the classroom.

According to Esterhuyse (2015:41-42), the benefits of lesson study may be summarised as follows:

- It is a powerful way for lecturers to examine their daily practice and to discuss their daily teaching activities
- It cultivates motivation in lecturers to keep on learning
- Lesson tools in the form of lesson plans and other tools may be shared among other lecturers, thereby building lecturer communities of resources.

According to Kuramoto and Shi (2012:143-144), some of the benefits for management and leadership are as follows:

- Collaborative and positive school culture
- Transformative leadership
- Supportive leadership
- Cooperation among schools
- Enhancement of vision and mission of schools
- Progressive schools

LS was very beneficial in a study done by Esterhuyse (2015) in which an adapted LS was employed to investigate the impact of planning lessons collaboratively and reflecting on one another's ideas and hence one's own metacognition (thinking about your thinking). In a study by McDonald (2009) it was clearly shown that content knowledge was increased among teacher participants, teacher practice changed in a positive manner and the majority of students demonstrated improved learning outcomes.

Disadvantages or challenges of LS has mainly to do with its implementation, time constraints experienced by participants and lastly, institutional and management support (Ogegbo, Gaigher & Salagaram, 2019:6-7). As far as implementation is

concerned, it sometimes happens that lecturers who were initially planned to be part of the LS team leave to take positions elsewhere as happened in the present study. Furthermore, participants are, on occasion, occupied in other activities when meetings for LS are scheduled. In such cases the LS proceeds without the team member which can impact on the outcomes. As far as time is concerned, lack of time is cited to attend meetings or the delivery of the LS. Time constraint is commonly cited as a challenge that limits teachers' continuous practice and effective participation in LS. The process is also time-consuming and there appears to be clashes in timetables for lecturers to meet. Since this is not adequately addressed by managers and administrators, participants feel that there is a lack of support from managers and leaders and that they are absent from the process.

Hence, this study focused on managers and leaders becoming participants in the LS process from its inception to its completion, leading, facilitating and driving the process in an observer capacity in order to guide and keep the process on track. This is important as it motivates the participants, empowers them and it results in sharing expert knowledge. It also provides managers with a strategy in which they can use LS at the TVET college and contributions they can make to the LS process and later. Hence, the participative LS model is designed in this study as an outcome of this participation.

Lastly, is important to mention one other observation from the literature at this point. Before one draws the conclusion that implementing LS at schools report only success stories, it is worthwhile to reflect on a study done by Bjuland and Mosvold (2015) that reports on a negative case in the implementation of LS in teacher education where a Mathematics group struggled with its implementation. It is powerful and enlightening to learn from mistakes made by others; hence the reason for including it here. In this particular study certain crucial aspects of LS were missing, such as not formulating a research question for the research lesson, not focusing on observing student learning and lastly, the research lesson was not organised to make student learning visible. Other studies on LS have adapted LS to suit their specific purpose (Posthuma, 2012). This is fine as long as the fundamental principles of LS are not distorted.

2.4.3 The impact of leadership and management on LS

Research done at schools where performance was poor, successful turnarounds were reported where and when a facilitator was present to guide the process of change. In such schools where the facilitator focused on the instructional program, provided structured time for planning and reflection, provided a structure for standards, led to a supportive, collaborative school culture (Lee 2012: 30). Furthermore, in LS with the support of a facilitator to guide the LS process, instructional knowledge and skills have a long- term effect on lecturers and impacts on student's performance.

In this study the facilitator is the manager as an education specialist and the main role of the manager is to steer the conversations and discussions for lecturers and to challenge, solidify and refocus on collaborative lesson planning and provide opportunities to probe deeper into the reflection process (Rock & Wilson, 2005:89). Managers as facilitators also held key roles in guiding instructional conversations, shared ownership of co-planned lessons, trust among participants and ensuring that all voices were heard. LS where managers as facilitators were not involved resulted in participants offering superficial feedback to their peers rather than constructive criticism. It was also found that where managers are absent, participants were unable to push each other towards greater levels of instructional mastery (Kratzer & Teplin, 2007:31-42). Hence, managers as facilitators serve as strong advocates for the LS process, providing various forms of support to motivate lecturers to change their instructional practices through their instructional leadership.

2.5 THE MANAGEMENT OF MATHEMATICAL LITERACY AT TVET COLLEGES

The subject ML at TVET colleges is managed by each college in implementing the curriculum as directed by the DHET. In the Western Cape (WC) the implementation of the ML curriculum is discussed at the annual Focus Group meetings where the assessment and moderation plan as well as the year plan is designed by selected ML coordinators from the colleges in the WC. The year plans give an outline of the five topics in ML in terms of subject outcomes (SOs) and learning outcomes (LOs) and the

time frame in which it needs to be covered. This is informed by the subject and assessment guidelines made available by the DHET which must be strictly followed by every TVET college. Every education specialist who, in most cases, is also the coordinator for the ML subject at his/her college, together with the campus head, ensures that the ML subject is implemented by following a daily timetable and strictly adhering to the year plans and assessment and moderation plan.

Assessments are common assessments designed by members of the Focus Groups who are appointed for coordinating the process. This standardised process leads to every college ensuring that their assessment is written on the same day as far as possible to ensure uniformity. Qualified lecturers are appointed to deliver and implement the subject and the recruitment and appointment is managed and handled by the education specialist in conjunction with the campus head and human resources. Lecturers who see to the delivery of the curriculum are also involved with intervention in cases where students' performance is poor and below par.

Intervention programs at TVET colleges are also the responsibility of the managers (education specialists) at their respective TVET colleges who must drive the process and ensure its effective implementation. Intervention for ML takes many forms and differs from college to college. It takes the form of PD programs where lecturers may go on workshops to improve delivery and thereby improve performance of students in the subject. These workshops concentrate on student-centeredness and problem solving, but as mentioned elsewhere and in literature these workshops are hardly effective as they are once-off. LS is a powerful and alternative intervention process which can improve lecturers' as well as students' performance as noted before. How both intervention and LS is implemented at a TVET college depends to a large degree on the management and IL style of the manager(s) as well as the organisational culture prevalent at the TVET college.

2.5.1 Management and leadership

There is a difference between management and leadership and every manager employs a different leadership style. Through their leadership styles they influence the organisation and its organisational culture. This is very strongly stated by Nanjundeswaraswamy and Swamy (2014:57) as 'Organisational culture is influenced by leadership style and consequently, leadership style affects organisational performance'. One way of influencing the organisational culture of an organisation is through the behaviour of its members and it has to be considered as an important variable when transforming organisations (Bell, Chan & Nel, 2014:1970). Employing LS through a participative model as proposed in this study can transform organisations in many ways. A positive and collegial relationship can be created when leaders work in collaboration and participate with subordinates. This collaborative participation often results in respect and trust among leaders and subordinates which positively improves confidence in staff and eventually results in a positive organisational culture. Leadership is a critical factor in determining the success of an organisation and its organisational culture, in that it mediates the association between leadership styles and organisational performances (Bell, Chan & Nel, 2014:1970).

2.5.2 Organisational culture

The effectiveness of education institutions such as TVET colleges does not always only depend on the resources such as human resources and physical resources, but also depends on the nature of the organisational culture of the organisation. In order to achieve and improve a positive culture of teaching and learning at education institutions it is important for managers and leadership to manage the different curricular and extracurricular structures at education institutions through a positive culture.

Organisational culture is defined as reflecting the underlying assumptions about the way work is performed, what is acceptable and not acceptable, and what behaviour and actions are encouraged and discouraged (Van Deventer & Kruger, 2003:19). Organisational culture is sometimes also loosely referred to as 'the way we do things around here' and 'what we think is true' (Friedman, 2005:20). The implication of this is that if we want to change or transform an organisation, we must change how things are

done at the organisation. LS is one way of changing how things are done at organisations by looking at how management can change things, as managers have a direct impact on the culture of an organisation.

According to Kuramoto and Shi (2012:136), a very important part of improving a school/ college is the school's organisational culture and without an efficient school organisational culture it is not easy to improve a school. A positive organisational culture must exist and in order to create a positive school culture, the roles of curriculum leaders (education specialists at TVET colleges) are indispensable for the progress of the LS system through trying to influence and motivate organisational participants (Kuramoto & Shi, 2012). Although managers might not be able to directly influence and motivate organisational participants, they have considerable ability through indirect means such as LS, as LS may be one way to change the culture of an organisation (Friedman, 2005:21).

In connection with the above, Hallinger (2012) also mentions how the dimension of promoting a positive learning climate affects the organisational performance of an institution and through that the organisational culture. He also claims that the three dimensions, namely, defining the school's mission, managing the instructional program and promoting a positive learning culture are mutually linked.

One way to build a strong culture is for management to become involved in all aspects of running an organisation, from developing strategies by top management, to directing employees at the lowest level. However, one finds that most managers make decisions at the top and are not always involved with the staff doing the work. According to Friedman (2005:23), top-down decision making negatively affects and impacts on the teacher's ability to reach consensus on initiatives that might affect change. This is also true at education institutions, at schools, colleges and universities. LS is also more successful where there is an 'open culture' and where bureaucracy is minimal.

It is reiterated by Friedman (2005) that leadership must play a key role in discussions on teaching and learning and pedagogical issues at the teacher's level. This can be done by creating good and positive relationships among teachers, managers and students. When managers become involved with the staff at the lowest level, such as when

education specialists become involved with lecturers in their lecture rooms, taking the initiative and leading intervention programs, it creates a positive ethos or a positive college culture. It is the participative collaboration aspect of LS that will bring about a positive environment and culture because it is generated through a positive relationship between the organisation and teachers and among teachers as well as among teachers and students. This has a direct and indirect impact on school improvement through improved academic performances (Kuramoto & Shi, 2012; Friedman 2005:23).

For management to become involved with lecturers at the classroom level, it is also important for management and leadership approaches to evolve and hence to de-emphasise the individual leader and emphasise group or team leadership (Mataboge, 2014:1). This brings about the notion of participative management and decision making. Real educational transformation requires of education institutions, such as schools and colleges, to shift away from traditional, bureaucratic management practices in order to cope with the demands of a democratic school culture (Mataboge, 2014:ii). The leadership style the leaders of an education institution adopt plays a major role in determining whether any change will be successful, including LS.

2.6 LEADERSHIP STYLES

Teresa (2013:15) describes leadership as the ability of a manager to induce subordinates to work with confidence and zeal and it is the means through which the leader guides the behaviour of other people towards goal accomplishment, while Yahya (2015:23) describes leadership as a process of influencing the activities of an individual within a group in its effort toward goal achievement in a given situation. In the case of LS, the goal is to achieve improved student performance through the collaborative planning of a research lesson.

A leadership style encompasses consistent combinations of individuals' behaviours and attitudes towards group members in order to achieve goals. The literature identifies at least four leadership styles, namely autocratic, democratic, Laissez-faire and charismatic (Van Deventer & Kruger, 2003:142-145; Teresa, 2013:20-23). Briefly, the

autocratic leadership style is characterised by directive leadership (autocratic leadership) and entails letting the subordinates understand what exactly is expected of them and giving them directions. The subordinates are expected to act by the rules and the regulations. Leadership by directives has been described as autocratic, oriented to specific tasks, manipulative and persuasive. Autocratic leadership tends to be highly structured and hierarchical and as such may create a negative relationship between the leaders and the subordinates (Teresa, 2013:20). According to Van Deventer and Kruger (2003:144), the autocratic leadership style is characterised by little teamwork, the leader making all the decisions and all control is vested in the leader.

The democratic leadership style, according to Van Deventer and Kruger (2003: 144), is characterised by teamwork, consultation and involvement of staff and learners in the decision-making process. This leadership style is also referred to as participative leadership and has a consultative nature; it values the input of subordinates. The study by Nanjundeswaraswamy & Swamy (2014:57) reveals that democratic leaders take great care to involve all members of the team in discussion and can work with a small but highly motivated team.

The Laissez-faire leadership style is one where the leader waives responsibility and allows subordinates to work as they choose with minimum interference. The employees are given the authority to make decisions or determine a course of action (Teresa, 2013:24-25).

From a modern perspective, two other forms of leadership styles discussed in the literature is transactional leadership and transformational leadership. Of special significance to this study is transformational leadership, which has the characteristics of individual influence, spiritual encouragement and intellectual stimulation. It often takes individuals into consideration, establishes vision and aim internally, creates an open culture and trusts the staff to reach their goals. Transformational leadership is related to organisational culture and organisational change in that, as a component of participative

management, it is a tool for organisational change and development (Bell, Chan & Nel, 2014:1971).

A number of studies found there is a positive relationship between change (such as the case through LS), transformational leadership and organisational performance through participative management (Samad, 2012; Danish, Munir, Nazir, Abbasi & Hunbal, 2013; Manshadi, Ebrahimi & Abdi 2014; Bell, Chan & Nel, 2014). Hence, in order for LS to be effective and successful at TVET colleges and managers intending to use LS as a management strategy to improve performance, it must go hand in hand with participative management and transformational leadership.

2.6.1 Participative management

Buthelezi (2016) defines participative management as the process whereby employees play a direct role in setting goals, making decisions, solving problems and making changes (transformation) in an organisation. Buthelezi (2016) further points out that participative management takes place when management and employees are jointly involved in making decisions on matters of mutual interest where the aim is to produce solutions to the problems which will benefit all concerned.

Two very important aspects that PM is based on are firstly, that it allows those involved with the work to be the contributing members in the decision-making process, and secondly, that leadership styles and current best practice ideologies assert that sharing the work with those who are actually doing the work produces more efficient and effective practices at the college level (Rock, 2017:3 & 5). Furthermore, studies done by Danish et al. (2013:1341) in investigating the effects between knowledge sharing, participative management and transformational leadership on organisational performance posit that leaders who employ PM affect their administrative power positively and it leads to organisational effectiveness. The same authors also assert that lecturer performance is enhanced when PM is used through their participation in educational decision-making processes, an aspect which is also at the heart of LS.

Intervention and improvement programs in mathematical subjects, or any other subject for that matter, will not be sustainable or successful in the absence of instructional leadership or management initiating and driving the process. In many cases, however, leadership is not part of the intervention process to improve performance. Research conducted by Belgrad (2015:15) found that one of the greatest factors central office people (these include managers, education specialists and instructional leaders) can contribute is to maintain a singular focus on improving instruction.

Some authors have also mentioned the contributions, visibility and support that managers bring to the process of IL by being part of the process. As far as improvement in Mathematics is concerned, Vale, Davies, Weaven, Hooley, Davidson & Loton (2010) mention two very important issues, namely, the absence of IL and the importance of effective leadership. According to these authors any efforts to improve performance in Mathematics fails in the absence of IL. Furthermore, effective leadership is needed to support and transform teaching practice. Their study further advises a move away from the manager as administrator towards manager as learner and leader of learning (Vale et al., 2010:49).

Instructional leaders and managers need to stay up to date in their specific fields and the best way to do this is to be an equal player in the process. In cases where projects to improve performance in mathematical subjects is initiated, it is necessary for IL and management to become involved with lecturers or their teams. This can be achieved through leading by example, such as presenting and delivering lessons, prioritising students and increasing their own content knowledge, a view strongly corroborated by Jaca (2013). The implication of this is that managers must be on the ground, visible and taking a leading role with lecturers and students of ML. Being visible is also a strong element in terms of one of the important dimensions of Hallinger (2012), although in this present study it is far more prominent in the sense that visibility is one of the prerequisites of the LS participative management model.

Managers and IL becoming part of instruction in the classroom along with lecturers and students is also highlighted by Fick and Resnick (2001) who focus on analysing

instruction as it happens in the classroom. This is nothing more than what LS proposes, in that it is job-embedded and the analysis of instruction as and when it happens at the observation stage of LS and the debriefing period immediately thereafter, and not after the fact. Jita (2010) concurs and alludes to the fact that policies by management do not bring changes to classroom practice and managers who focus on instruction together with daily managerial duties made greater improvements in mathematical subjects. One is not downplaying the fact that administrative matters and daily management tasks consume the bulk of a manager's routines, but time spent with teachers in classrooms can be valuable as the LS process demands. Fick and Resnick (2001) proceed to mention that the traditional classroom observations should not be confined only to appraisal purposes, but be a mechanism to develop staff and also to assist students directly. The development of staff requires effective and efficient leadership.

The implementation of LS cannot commence without the involvement of efficient and effective leadership and management of the process. The leadership factor in the implementation of LS is therefore a very crucial element (Utaminingsih, Murtono & Utomo, 2017:260). These authors further find that the commitment of the leadership ultimately determines the success of lesson study and the quality of the improvement in learning.

Participative Decision Making (PDM), a component of PM, refers to the concept of allowing those involved with the work to be contributing members in the decision-making process. The ultimate idea behind participative leadership practice, is to achieve school effectiveness through the collaborative effort and joint decision making involving managers, teachers and students. A study by Gyasi (2015:2) reveals that the headmaster's collaboration and jointly made decisions with the teachers through participative leadership practice have the potential to develop and improve schools. It was also found that the headmasters, teachers and parents accepted that each of them should perform some identified roles in order to improve the practice. All the above concepts of LS, IL and PM relate to and have an impact on one another.

2.6.2 The relationship between LS, IL and PM

From the aforementioned it is quite obvious that there is a clear relationship between LS, participative management and IL. Schools and TVET colleges need conditions, elements and facilities which provide them with approaches, strategies and tools required in facilitating the lesson study process (Farhoush, Majedi & Behrangi, 2017). While LS cannot be successful without collaboration, or expressed in another way, it is non-existent without collaboration. It is just as true to say that LS is also non-existent without participative management. This participation among the LS team is crucial, but it is also necessary between the LS members and the manager. On the other hand, leadership and management through participative management and IL is also dependent on some kind of transformational process, such as the process of LS, to achieve organisational goals as LS is located at the centre of a growing positive college culture (Kuramoto & Shi, 2012).

The process of LS also fits quite nicely into the management cycle of planning, doing, checking and acting (Kuramoto & Shi, 2012). First, the school educational goal should be established (plan). Secondly, it is necessary to make a strategic teaching plan via a curriculum, to implement the curriculum and actual teaching lesson (do), and to evaluate the educational effectiveness (check). Finally, the product is an improved qualitative curriculum and teaching strategies in a school year (action).

According to Farhoush, Majedi and Behrangi (2017), LS is a participative action research by teachers in a school and a classroom. It gathers teachers together in the question of designing, planning, action, active observations, feedback and re-thinking of learning processes. It also encourages them to exchange views, experiences, co-action and learning from one another. It therefore has a powerful effect on the professional training of teachers, improving the quality of teaching, continuation of changes for school improvement, improving students' learning and absorbing active participation of teachers in defining the ideas, plan of action and effective administration of the school for reconstructing it as a learning organisation.

In order to create a positive school culture, the roles of principal and middle leaders are indispensable for the progress of the LS system (Kuramoto & Shi, 2012). LS is an

innovative PD tool incorporating teacher-led action research with the ultimate aim of improving the school's organisational environment and students' learning in the classroom. The key concept for the LS is the emphasis on the collaborative school culture, in which individual lecturers are able to share their professional visions and missions with other lecturers to improve teaching skills and morale, and indirectly to advance student achievement.

According to Rock (2017:11), high participatory programs such as LS at education institutions have the following outcomes:

- Decision making is collaborative and consensus-driven
- Focus is on the college mission, instructional leadership and development
- Leadership is shared among managers and lecturers; both take the initiative and both assume responsibility.

According to Rock (2017:7), the impact and benefit for management of bringing together PM and LS in an educational setting via IL may lead to the promotion of creativity, a positive educational culture and shared and collaborative leadership, which are all important elements for using LS as a management strategy to improve performance at TVET colleges.

2.7 CONCLUSION

This literature review first investigated some reasons why performances are poor at schools and TVET colleges in both Mathematics and ML. The review then explained LS by looking at the steps involved in the process and the different studies conducted thus far in LS, and discussed the collaborative benefits of LS as well as other benefits for education institutions, for management and leadership and how they can use it to make contributions toward it. Reference was also made to some disadvantages and challenges of LS.

The literature review then discussed the management of ML at TVET colleges and how the management of ML is affected by the management and leadership styles of the managers of the college and how it affects the organisational culture of the organisation. Different leadership styles were discussed and reference was made to the transformational leadership, emphasising the use of participative management as a vehicle to make LS effective. Lastly it explained the relationship between PM, LS and IL and emphasised the harmonious collaboration between the three activities for making education institutions effective.

CHAPTER 3

THEORIES UNDERPINNING THE STUDY

3.1 INTRODUCTION

In this chapter the theoretical framework is presented as the foundation on which one's research is based and underpinned. It is one of the most important aspects of the research process (Grant & Osanloo, 2014:12). It is there to guide the research process and offers a lens through which to examine the topic. Therefore, a theoretical framework is the application of a theory which offers an explanation of an event or a particular phenomenon (Imenda, 2014:189). The choice of which theory to apply to explain the researcher's problem, is an aspect which every researcher wrestles with.

In some cases, a research problem cannot be guided or researched with reference to only one theory, and it seems clear that LS, specifically, and the research problem under investigation in this present study, compelled the researcher to investigate it from several related concepts by synthesising and integrating it into a conceptual model. According to Grant and Osanloo (2014:16), the conceptual framework offers a logical structure of connected and interconnected concepts that help provide an image or visual display of how ideas in a study relate to one another within the theoretical framework. The theories are also used to explain the study under investigation.

The nature of LS is such that more than one theory may be used to guide and explain the process and the research problem which is being investigated. Hence, in this study more than one theory was used as a lens to explain the different facets of the research question and sub-questions being investigated. Since every stage of the LS process requires a different type of skill, different theories can be used to explain and be underpinned by the particular theory or a combination of them. Since this study also investigated the impact of LS on management and managers, as well as how managers can contribute to the LS process, it also referenced many theories in management. The theory of management which is very relevant to LS is participative management. The process of LS puts together many different skills not only for students, but also for lecturers and managers.

The main feature underpinning LS is to enhance teachers' professional development through a work- or class-embedded cyclical process that comprises curriculum study and goal formulation, planning, conducting research and reflecting on the research lessons (Lucenario, Yangco, Punzalan & Espinosa, 2016:3). This work or class-embedded cyclical process gives rise to the idea or concept of team-based action research which can assist in enhancing the outcomes of LS.

3.2 THEORIES UNDERPINNING LESSON STUDY

3.2.1 The theory of social constructivism

One of the theories underpinning LS is the theory of social constructivism. Fundamental to the theory of social constructivism is the fact that students do not enter the education environment as empty vessels, but with some knowledge and experience which they have acquired through their own experiences. Students then receive new knowledge by using the old knowledge and constructing their own, based on prior knowledge and experiences (Olivier, 1999:24). According to the principles of constructivism, individual learners construct knowledge through a social process of sharing and interacting in a specific social or cultural context (Guba & Lincoln, 1989; Hamzeh, 2014:18). This implies that educators must take this into account when designing lessons, especially the research lesson in LS, to highlight the social and sharing aspect of the lesson.

The theory of social constructivism is generally attributed to Jean Piaget who formalised it by proposing that new knowledge is actually constructed by a process called assimilation and accommodation. When individuals assimilate, they incorporate new experience into an already existing framework without changing that framework, while accommodation is the process of reframing one's mental representation of the external world to fit new experiences.

Other contributors to the theory of social constructivism include the theory of social constructivism put forward by Lev Vygotsky from 1978 onwards. Vygotsky suggested that knowledge is first constructed in a social context in a sharing and collaborative environment and is then appropriated by individuals. The sharing and collaboration is at

the centre of LS. Lecturers in LS share ideas, knowledge and skills and hence build a shared knowledge base which can easily be accessed by lecturers at a TVET college (Abdella, 2015:54). Vygotsky's social constructivism theory describes learning as a social process and everything which is studied is learned at two levels. The first level is through interaction with others, and the second level takes place when it is integrated or internalised in human mental processes (Cole et al., 1978). In LS, the social process is activated when lecturers interact with one another, for example, when deciding on the goal of the lesson in LS and through all the other stages of the process where it features strongly. When lecturers start using that which they have learned through the LS process successfully in their lecture rooms, such as improvement in understanding the content, different methods of delivering a lesson, observation skills as well as reflection on lessons, it becomes internalised.

Vygotsky also advanced the well-known concept of the Zone of Proximal Development (ZPD). It refers to the range of psychological functions firstly between those functions which the individual is able to master without assistance, and secondly, those functions which the individual can manage if given assistance. The range in between these two limits is called the Zone of Proximal Development (Blunden, 2011:8). "What a child can do today with assistance, s/he will be able to do by herself/ himself tomorrow," Vygotsky said. Acknowledging this concept can help both student and educator. It helps the lecturers participating in the LS process in the sense that lecturers who work with others in a group are assisted by other more knowledgeable lecturers, while when educators work collaboratively with others in the LS team, they also decrease the gap of ZPD. Thus, lecturers in LS receive exposure to various strategies on how to handle and approach the teaching of a particular Mathematics or ML concept.

Vygotsky emphasised that children and adults are both active agents in the process of a child's development. With reference to teaching, it means that both the teacher and the student are seen as active agents in students' learning. Consequently, in LS one of the lecturers at a particular instance will instruct the class while other lecturers, who take the position of observers, will be students learning from the approaches applied. The teacher's intervention in student learning is necessary, but it is the quality of the

teacher-learner interaction which is regarded as crucial in that learning. For example, learning may be enhanced with student-centred activities and problem-solving activities, removing the teacher-centred approach and placing more emphasis on compelling the teacher to produce lessons with the student in mind, leading to lessons with a high-quality impact.

According to Jones and Araje (2002:2-3), the educational applications of the theory of constructivism is visible in three areas of teaching:

- Reciprocal teaching, which involves interactive dialogues between teacher and groups of students. At first, the teacher models the activities then the teacher and students take turns in modelling being the teacher, when the activities become student-centred. For instance, when a problem-solving activity is provided in ML and it elicits or prompts asking questions from students in the observation stage of LS, the educator can use these questions as prompts in the instructional sequence of the lesson plan. This leads to social interaction between educator and students and helps to assist in the ZPD.

- Peer collaboration: The shared social interactions when peers work on tasks cooperatively serve an instructional function. LS could be one of those instructional functions. This method is mainly used in learning Mathematics, science, and language arts which attests to the recognised impact of the social environment during learning. The social environment which emanates from LS might impact on both students and educators since educators learn from one another and share with one another through designing research lessons. LS also has a social impact when students learn in a cooperative manner through group work and student-centred learning, which may result in a positive social atmosphere in classrooms at TVET colleges.

- Apprenticeship programs: as they occur in cultural institutions like schools and agencies, which help in transforming learners' cognitive development. On the job as in LS being in-class PD, apprentices operate within a ZPD as their work mainly depends on tasks beyond their capabilities. Apprentices develop a

shared understanding of important processes by working with experts and integrating this with their current understanding. This is applicable in LS when the knowledgeable other becomes part of the LS process. Based on those applications, it becomes important in this study to manage the environment in which LS operates such that the mentioned areas of teaching were used to empower teachers.

The theory of social constructivism informs this study at three levels. Firstly, when students were provided with a real-life problem to solve, which was engaging, as is the case with the contextual nature of problems in ML, it brought into play the student-centred approach. Hence, LS can never work in the traditional teacher-centred approach of delivery. Furthermore, for lecturers working together to solve the problem, they were compelled to interact with one another socially, discussing, arguing and deliberating the context of the problem and thereby arriving at solution(s) of how best to plan and design the research lesson, deliver the lesson and come up with a format for observation. The social interactions, discussions and deliberations were the result of their prior knowledge and own experiences with regard to the context of the problem.

The collaborative approach of LS compels lecturers to interact with one another socially at the level of the lecturer. This occurred in many stages during the LS process, when lecturers decided on the topic, planned the lesson together, and conducted debriefing and reflection sessions together. Lecturers also reflected on their own practice and discussed the performance of the students as observed in the lesson. The lecturers in each of those processes brought with them their prior knowledge and their own approach as proposed by the theory of social constructivism.

Lecturers also worked together to solve problems of curriculum and areas in the curriculum, as in this case, space, shape and orientation (SSO). Relative to adults, sociocultural theorists argue that individual teachers learn through “situated” interactions with other teachers in their existing social relationships and communities of practice (Lave & Wenger, 1991). According to Lave and Wenger (1991), they are active agents in constructing knowledge, and learning emerges through conversations and interactions among colleagues. An inquiry into lesson study fits well within sociocultural

learning frameworks because teachers participate in lesson study and students ideally form learning communities that engage in critical and reflective discussions about instruction (Bocala, 2015:350).

3.2.2 Social cognitive theories

Other social theories which determine and influence a person's belief whether a process will be successful or not, are the theories of Bandura's social cognitive theory and Bruner's cognitive learning theories, both in educational psychology. Bandura's theory asserts that human behaviours in terms of beliefs, motivation, goals, accomplishments, and personal well-being may be shaped by various social interactions and it influences the person's experiences. Bandura's theory declares that people are active participants in their life experience and their cognitive functioning serves as a significant determinant that impacts on their lives (Naureth, 2015:19). It is important for managers and lecturers to be aware of this theory and how it applies to LS. Both lecturers and managers are shaped by their background and beliefs and any process they enter into will be determined by this background. When lecturers and/or managers believe that the LS process can be successful, it will have an impact on how they see it and the resultant outcome of the LS process.

Two very important constructs emanating from Bandura's theory are self-efficacy and outcome expectancy. Bandura (1997) defines self-efficacy as, 'beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments' (1997:3). 'An outcome expectancy is defined as a person's estimate that a given behaviour will lead to certain outcomes' (Bandura, 1977:193). Self-efficacy and outcome expectancies are clearly distinguished from one another, in that, self-efficacy is built upon the perceived ability to do a certain behaviour, whereas outcome expectancies are judgments about the likelihood of the outcomes that result from such behaviours.

Bandura's self-efficacy theory is very pertinent in the application of LS as it has an effect on teacher's efficacy as well as the student's efficacy in the sense that LS is supposed to improve both lecturer's and student's knowledge. The construct of teacher self-efficacy beliefs was born from Bandura's social cognitive theory. As far as teachers are

concerned, teacher self-efficacy is the belief held by a teacher about his/her ability to teach effectively, while outcome expectancy beliefs are a teacher's belief in the ability of his/her students to learn. Both these constructs are important factors that influence the education of students, as these beliefs impact teacher behaviours within their classrooms (Gibson & Dembo, 1984). What this implies for teachers is that individuals are more inclined to attempt a task if they feel they are capable of success, for example, in terms of implementing a new curriculum, a new teaching approach, such as LS, or being successful in a team.

Bandura's (1997) theory was also applicable to managers in that the belief held by the manager in his ability to implement the LS process and getting team members to participate collaboratively is part of a manager's task when working in the team. It is important to attain the objectives of improving the results of the students in ML and it depends on the manager's self-efficacy. Furthermore, the belief that the manager holds with regard to what positive and effective changes he/she can make, with regard to the outcomes of empowerment, collegiality, effect on curriculum and sharing knowledge among others will greatly influence the success of LS. Drawing from the theories discussed above, the concepts of Constructivism (Vygotsky), Communities of Practice (CoP), LS and Participative Management (PM) underpin this study and the LS–PM model is an outcome of this study. In the study under investigation, the manager (researcher), because of his belief that the LS process would work and the concomitant belief of the participant lecturers and their commitment, resulted in the success of the LS at the TVET college. Lecturers felt empowered by the experience LS offered them and sharing knowledge among lecturers and the manager enhanced the success of the LS process.

3.2.3 Lesson study

Lesson study consists of a detailed study or examination of the practice of teaching and learning. The process was developed in Japan and is built on the premise that the best way to improve education is to 'get teachers together to study the processes of teaching and learning in classrooms, and then devise ways to improve them' (Bush 2009). Teachers who together engage in lesson study undertake a cycle of activity which is intended to investigate and improve a specific aspect of classroom technique. This results in student's learning to progress and improve because pedagogy is better designed and delivered.

According to Burghess & Robinson (2010:7-8), LS is based on three principles:

- teachers learn best from and improve their practice by seeing other teachers teach. This principle speaks to Bandura's theory in the sense that by observing the behaviours of others, people develop similar behaviours (Nabavi, 2012: 5).

- teachers who have developed a deep understanding of and skill in subject matter pedagogy should share their knowledge and experience with colleagues. Sharing ideas and knowledge with the participants in LS is fundamental to LS in all its phases and steps. The last step in LS is to share one's findings with other non-LS members of the college. The knowledgeable other also plays a significant role in this principle.

- teachers should cultivate students' interest and focus on the quality of their learning. The activities students must engage in should be student-centred and include activities such as problem solving and discoveries, thereby capturing the students' interest. Observation, which is part of the research lesson, is a non-negotiable step of LS. Observation in LS assists educators in focusing on the quality of student learning and the quality of educator teaching when more than one educator observes case students specifically and the rest of the students generally in the research lesson, while one educator delivers the LS. Debriefing and reflection of the lesson by the LS team after the lesson has been delivered enhances the quality of both the students' learning and the educator's teaching

as it assists in improving lessons. The role of the manager in the process of LS is to provide support, guidance and be a participant observer in the entire process of LS. At a higher level the role of the manager is to share the process with the entire college community with other managers to improve organisational transformation.

The majority of the theories thus far developed in education find a place in LS and it is a great platform for most of those theories to be put into action. Literature around the theoretical underpinnings of lesson study differs from author to author and researcher to researcher. According to the researcher, for example, the theoretical underpinnings on which LS is based can safely be placed into six categories, namely the impact of LS on professional development, communities of practice (CoP) and the influence on collaboration, Vygotsky's social constructivism, pedagogical content knowledge and related theories, social cognitive theories of Bandura and related theories, and management and instructional leadership influence on LS and the impact of LS on management.

Furthermore, while some researchers have included all the categories above to explain LS (McDonald, 2009), others have used only one theory such as Shúilleabháin (2015). Table 3.1 below lists the theory and the researcher:

Table 3.1: Theory underpinning LS and theorists involved.

Theory underpinning LS in the research	Author/Researcher
Professional development (PD)	Rock & Wilson (2005) Hix (2008) Lee (2012)
Communities of practice theory (CoP)	Bergenski (2008) Bocala (2015) Seobi & Wood (2016)

	Corcoran (n.d) Saye (2007) Lucenario et al. (2016)
Constructivism (Vygotsky)	Rock & Wilson (2005) Wright 2009 Hix (2008) Bocala (2015)
Social cognitive theories (Bandura)	Posthuma (2012) Postholm (2012) Naureth (2015) Watson (2013)
Pedagogical content knowledge (PCK)	Botha (2011) Verhoef and Goei (2015) Coenders and Verhoef (2018) Shúilleabháin (2015) Shulman (1986)
Various management and instructional leadership theories such as participative management	Bergenski (2008) Bocala (2015) Stephens (2011) Seobi & Wood (2016) Kuramoto & Shi (2012) Smith (2008)

The most common theories referred to in the literature that underpin LS, are those of communities of practice; Vygotsky's constructivism; social cognitive theories and management and leadership. The researcher also found that the category of management and leadership theory in terms of how managers can use the theories of management and leadership and the contributions they can make are rare and

scattered. Hence the researcher developed a model which explains the impact of participative management on LS when managers are part of the LS process, thereby answering the questions of how managers can use LS, what contributions they can make and how the LS model can be modified to include managers.

3.2.4 Communities of practice theory

Community of practice (CoP) theory also guided the application of LS in this study. As already mentioned above, lesson study does not work as a solo effort since most of the elements of LS such as (a) identification of the lesson goal, (b) designing the lesson, and (c) observation of the lesson are collaborative processes. This means that it requires a team (or community) wherein each member of the team has to provide input through participation. As lecturers engaged in this process of LS, they functioned/ operated as a community, more specifically, communities of practice (CoP), which are groups of people who share a common concern and, by interacting regularly with this concern, learn how to do it better (Lenski, Caskey & Anfara, 2009:50; Wenger-Trayner, 2015:1). This has far-reaching implications for teaching and learning, instructional leadership (IL), management and participative management.

The concept of CoP originated in learning theory and it was coined when Anthropologist Jean Lave and Etienne Wenger were studying *apprenticeship* as a learning model. The term community of practice was coined to refer to the community that acts as a living curriculum for the apprentice within a social context. Both Lenski, Caskey and Anfara (2009:50) and Lave and Wenger (1991:33) advise that LS is an example of situated learning and therefore LS is underpinned by situated learning theory which advances the idea that it is a process of participation in communities of practice. Newcomers join such communities via a process of 'legitimate peripheral participation'. This means that as members join this community, they absorb the modes and actions of the community. This connects very well with the theory of participative management in the sense that, as members join, they start participating in collaboration.

According to Wenger-Trayner (2015:2), three characteristics are crucial for a community to be a community of practice, namely the domain, the community and the practice. It is important to mention what a community of practice (CoP) is not. It is not a club of

friends, but has an identity defined by a shared *domain* of interest for which the community has come together and has committed to a purpose. In the case of LS, the LS team came together to reach the goal articulated in stage 1 of the process.

As far as the *community* is concerned, members engage in joint activities and discussions, help one another, and share information. They build strong relationships that enable them to learn mutually; and they care about their standing with one another. This applies to the entire LS process from beginning to the end and is applicable at all three levels the researcher identified, namely for the student group, the LS team as well as the participative management process with the team working together with the manager(s). Establishing joint goals, improving learners' learning by working together and fine-tuning instructional activities are essential in a lesson study (Goldshaft, 2016:26). In this model of community of practice referred to in Goldshaft (2016), "the sum total of individual knowledge and experience is enhanced significantly through collective endeavour" (Kennedy, 2014 in Goldshaft, 2016:26). In the LS under investigation, it was easy for lecturers as participants to help one another and to share information by working together toward the goal of developing improved research lessons. It was a learning experience for all, as everyone looked at teaching and learning through new eyes. Strong relationships were built not just among the lecturers, but also with the manager who guided the LS process in a participative-management position.

As far as the *practice* part of CoP is concerned, it is a CoP which constitutes a community of practitioners within the same sector (lecturers in Mathematical Literacy, for example) who develop shared resources (research lesson or lesson plans) within this community and which can be utilised by this CoP. These resources may be the lecturers' experiences, tools and problem-solving activities. In terms of LS, this can be the experiences the different members have with regard to the topic or section of work with students and how they learn this section of work, for example, lesson plans and student-centred activities. Wenger-Trayner (2015:2) adds that it is the combination of those three elements that constitutes a community of practice; it is by developing the three elements in parallel that one cultivates such a community.

Communities of practice are a much stronger and effective form of professional development since it focuses on teacher learning communities rather than the more traditional ‘workshop’. This traditional approach of professional development in the form of ‘workshops’ have become a growing concern among educators and policymakers since it was found to be ineffective. In recent years there has been a growing trend to move away from this traditional approach (Lenski, Caskey & Anfara, 2009:51). McDonald (2009:38) further corroborates that traditional approaches to PD are no longer appropriate for transformational teacher change as it is totally disconnected from the real issues of curriculum and learning. Hence, LS is an approach which should be employed more often and at all education institutions.

Utilising communities of practice through the platform of LS is superior and more effective as it takes place in the lecturer’s classroom. This means it is work-embedded and working together as a team with other members to solve problems as and when they happen. This is unlike the traditional PD where there is no classroom situation and the solutions to problems are not found since they happen after the fact. LS as a form of communities of practice allows lecturers to work together as a team, focusing on a common goal or instructional problem on the job and together finding the solution to the problem.

It is widely accepted that being part of a community or team (such as a LS team) is not only one of the most powerful forms of PD, but that learning among members is more powerful than individual learning, which is a form of co-learning between colleagues. This participative management paradigm provides participation within the community providing for authentic conversations and experiences. It serves multiple purposes such as professional and collegial learning, enhanced instruction and school (TVET college) improvement. It also provides for a safe and supportive environment (Parker & Patton, 2017:352).

Parker and Patton (2017:352) extend Wenger’s theory of CoP somewhat further and promote learning as participation, social interaction and describe it as participation. The same researchers advance the view that working in a CoP results in being ‘better together than apart’ and paving the way towards collaboration. ‘Better together’ gives

group members the feeling that they are not alone and gives them an opportunity to be among like-minded colleagues with similar interests resulting in growth and development. This is nothing more than collegiality.

The collegiality which results from the participation in a CoP, paves the way to collaboration on topics of teaching which educators care about and wish to improve on as is the case with LS when the research theme or topic is decided on. This collaboration also gave rise to social and group dynamics that include:

- identifying a common focus to spark joint work
- developing personal and professional relationships
- safe but challenging spaces, and
- shared commitment (Parker & Patton, 2017:354 -358)

For professional development programs to be effective, they should be planned, run and involve the lecturer in the context where they work, as this allows them to work within their own frames of reference, thus helping them to focus on issues relevant to their situation (Makara, 2016:23). As a result, the final lesson plan which emanated from a single cycle of LS was used as input to inform curriculum documents, textbooks and assessment policies at the management level so that instead of a top-down approach to management, LS was used as a bottom-up approach through integration of LS and the participative approach.

3.3 THEORIES UNDERPINNING PARTICIPATIVE MANAGEMENT

In order to transform education institutions, and for that matter TVET colleges, it is crucial to transform the bureaucratic leadership styles and the other extreme, the *laissez-faire* leadership style, in use today at education institutions and make room for management styles that encourage inclusion and participation. *Laissez-faire* leadership styles refer to a leadership style in which leaders are hands-off and allow group members to make all the decisions which leads to the lowest productivity among group members. Participative management is one such form of transformational management

style that can make the application of LS at TVET colleges very effective. A climate for effective participative management and transformational leadership depends on the following elements according to Singh and Manser (2002: 56):

- Planning according to a shared vision
- Managing through participation and collaboration
- Developing the school as a learning organisation
- Drawing on support systems

All the elements above are also part of participative management and the process of LS as all four elements play a part in the process of LS.

Before discussing IL, concepts around leadership and management must be mentioned.

3.3.1 Leadership theory

The implementation of LS will be more efficient and effective if it is managed and controlled well. It also needs good direction, and good leadership becomes a crucial factor in the implementation of LS. In a study by Utaminingsih, Murtono and Utomo (2017:260) it was found that in the implementation of LS at education institutions, the commitment of leadership, planning ability and the culture in education institutions determined the success of LS in improving learning.

Closely related to the culture of an education institution is also the leadership styles of the leaders of the institution as different styles may affect organisational effectiveness or performances (Nanjundeswaraswamy & Swamy, 2014:57). Organisational culture is influenced by leadership styles and consequently affects organisational performance. The type of culture in an organisation and, for that matter, education institutions, influences not only the staff (lecturers), but also students and their eventual performance.

At the core of most definitions of leadership are two functions, namely providing direction and exercising influence (Leithwood & Riehl, 2003:2). At the heart of effective

leadership is mobilising and working collaboratively with others to achieve shared goals. According to Leithwood & Riehl (2003:2), the implication of this is as follows:

- leaders do not merely impose goals on others, but work with them to create a shared sense of purpose and direction. The implication of this for education institutions is that it is centred on student learning, academic knowledge and skills
- leaders work through and with other people for them to become effective to achieve goals directly and indirectly. Leadership is not about the 'I', but about the 'we'.

There are many leadership styles cited in literature such as democratic leadership, authoritarian leadership, charismatic leadership and *laissez-faire* leadership (Teresa, 2010; Yahya, 2015). According to Van Deventer and Kruger (2003:145), there is no one correct leadership style and different leadership styles might be required under different circumstances. Leadership styles may also vary from time to time under the circumstances (Yahya, 2015:23). Leadership styles usually move between leadership-centeredness to subordinate-centeredness (Van Deventer & Kruger, 2003:146). One form of subordinate-centeredness leadership style is participative management which includes concepts such as collegiality, shared decision making and transformation. All these elements are also present in LS.

Briefly, certain characteristics which describe the *laissez-faire* leadership style is passivity, lack of involvement and hesitation to make decisions; the autocratic style is characterised by little teamwork, decisions made only by the leader, and control vested only in the leader, while the democratic leadership style is characterised by teamwork, leadership through consultation and two-way communication (Van Deventer & Kruger, 2003:143-145).

3.3.2 Participative leadership and management

Although these different leadership styles have their time and place, to effect transformation in education these different types of leadership were quickly replaced by

what is today referred to as participative management (Mataboge, 2014). Participative leadership which is very close to democratic leadership and falls under subordinate-centeredness is used as a theoretical underpinning for LS in this study, as many of the elements of participative management are also present in LS.

Mataboge (2014:11) defines participative management as shared influence in the decision-making process by a superior and his or her employees that offers a variety of benefits to the overall school (college) and to its employees or lecturers (Day et al. in Mataboge, 2014:11). Buthelezi (2016:8) defines participative management as the process whereby employees play a direct role in setting goals, making decisions, solving problems and making changes in an organisation.

At the management level, the concept of participative management, as proposed in this investigation, brings managers and lecturers together in the LS process. This has far reaching implications for leadership at TVET colleges because the collaboration between managers and lecturers results in decisions which are made collectively in terms of curriculum, the research lesson and engagement with one another, becomes powerful. Through the process of LS, which includes managers in a participative approach with lecturers, a more open culture and environment is the result. This impacts positively in improved curriculum design through better teaching strategies and reflection. Decisions reached collectively by managers and lecturers on topics as in this case, space, shape and orientation through the LS process, may be used as input when curricula are designed at government level. Hence, it has a great impact on personal empowerment and self-efficacy for lecturers and managers which results in improved delegation by managers.

The LS process cannot work without a team of members committed to a particular purpose and it operates within a structure that facilitates the transmission, formation, reflection about lessons and instructional practices through a process of collaboration (Lee, 2012:32). Burgess and Robinson (2010:13-15) refer to this collaboration as ‘collaborative continuous professional development’ as it is present at each stage of the

LS process through the entire cycle. LS requires the participation of every member of the team as well as the manager participating with the team collectively and individually, or as a knowledgeable other. Hence, participative leadership has a major role to play in LS and it is essential and crucial for its success because all the members have to collaborate and participate. In the study under investigation lecturers willingly participated in the LS process, valuable input was given by all and the commitment was strong. Participation by the manager was also essential to keep the process on track by giving guidance and participating with the lecturers and providing his perspective and knowledge.

Participative leadership and management was introduced by Barnard in 1938 (Mahoney & Godfrey, 2014:1; Sinani, 2016:28) which alluded to concepts such as cooperation, collaboration, social life in organisations, community of practice and engagement with organisational goals and authority. It also included the ideas of collective decision making and shared responsibility. According to Reese (2009:161), participative management originated in the mind of Kurt Lewin (1890 – 1947) who based his work on the theories of Frederick Taylor. Lewin was committed to the democratic participation of the individual in all realms of life and especially in organisations. It is hoped through this study that LS can serve as a vehicle to apply participative management within a TVET college.

Closely related to the concepts of participative management or participative leadership are the concepts of democratic leadership, transformational leadership, collegiality, collaboration and shared decision making. All these concepts have many commonalities, with slight differences. It is also true that effective participation cannot occur without a democratic culture or democratic leadership. If the goal of any organisation is to transform, as is the case in this study, participative management is one effective strategy that may be followed. To highlight the relationships between these concepts and to indicate how they are connected, Creighton et al. (2007:17) summarises it as follows: “While transformational leadership is consistent with the collegial model, in that it assumes that leaders and staff have shared values and

common interests (Bush, 2003:76), the leadership model most relevant to collegiality is participative leadership".

Furthermore, one of the key ingredients to effective participative management is a collegial relationship (Reese, 2009:162), as decisions are made on the basis of individuals' knowledge. Collegial relationships refer to the cooperation and collaboration among colleagues for a common purpose such as, for example, improving performance in ML and how managers can implement it at TVET colleges. LS brings together all these concepts through group work, team culture and collaboration. The theoretical framework of building collegiality among teachers is social constructivism. Social constructivism emphasises that knowledge is constructed in response to social interaction through social negotiation, discourse, reflection and explanation. Through this social interaction, participants in LS become co-learning colleagues.

In the process of LS, all members in the group were co-learning participants inclusive of the manager (researcher) and the power of collaboration, collegiality and participative management comes to the fore through working in participation with one another. This co-learning culture through participative management extends to a collaborative culture through joint work, mutual observation and focused, reflective inquiry so that teachers (lecturers) and managers interact knowledgeably and assertively with one another (Awbery, 2013:32). Furthermore, collegiality is a form of social organisation based on shared and equal participation by all of the members. It implies collective responsibility and describes a group of people united in a common purpose who have respect for one another's abilities in working towards that purpose (Awbery, 2013:32). In this LS, the common purpose for both the manager and lecturers was to achieve teaching and learning outcomes such as improved teaching strategies, improved curriculum implementation, increased knowledge of the ML subject matter and content, observation skills and sharing knowledge. The other purposes as far as personal outcomes and managerial purposes was concerned was trust and respect for one another, improved collegial relationships through participation and participative management, improved

relationships between managers and lecturers, motivation and building confidence, and building a positive college culture.

Briefly, participative leadership is based on the following theories and studies (Sinani, 2016:28-30):

- The Hawthorne effect (1927 – 1932) is a term referring to the tendency of some people to work harder and perform better when they are participants in an experiment or research. It also showed that a supportive environment leads to positive effects on job satisfaction.
- Lickert's organisational theory (1967) which showed that among the different systems adopted by leaders, the participative leadership and management systems consistently delivered better employee organisational outcomes.
- Davis (1968) declared that increased participation and increased self-efficacy led to increased dedication and good work ethics.
- Maslow's theory of the hierarchy of needs and motivation (1943) indicated that the democratic leadership approach inherent in participative leadership delivered growth-motivated employees and resulted in highly motivated and satisfied employees.
- The theory of collegiality is the key to effective participative management and decisions are made on the basis of the individual's knowledge and where professionalism and mutual respect are key.

Participative management also encourages subordinates to discover new opportunities and challenges, to learn through acquiring, sharing and combining knowledge and skills to attain institutional or organisational goals and objectives. Hence it can serve as one way of enhancing exchange of information and thereby the development of teachers (Mataboge, 2014:11). From a collaborative perspective, Mataboge (2014) reaffirms that the collaborative culture is one of the main building blocks of participative management. The collaborative element in LS is also one of the most important elements and is part of every step of the process, from deciding on a goal to sharing the information with others.

The following table strives to compare the elements of similarities between participative management and lesson study.

Table 3.2: Similarities between participative management and lesson study

Participative management model	**Lesson study management model**
Managers and subordinates decide together on common organisational goals.	Lesson team members decide on common goal/s in terms of subject/ learning/ content goals to be covered in a lesson.
Managers and subordinates share knowledge and ideas in terms of organisation.	Lesson team members share ideas and knowledge in terms of subject and desired lesson.
Continuous collaboration between managers and subordinates in terms of the organisation.	Continuous collaboration between LS team members and researcher (manager) in terms of lesson plans, observations and debriefing sessions.
Managers and subordinates solve organisational problems together.	Lesson team members with the manager solve problems in terms of how learners think and learn.
Managers and subordinates are equal members in shared decision-making approach.	LS members and manager are equal members in shared decision-making approach.
Transforming the way the organisation operates.	Transformation in the teaching and learning approach resulting in transformation in teaching culture and institution.

3.3.3 Instructional leadership

The theory which is fundamental and underpins this study as far as instructional leadership is concerned, are the three dimensions of Hallinger (2012). Fundamental to the theory of Hallinger (2012) is his three dimensions of instructional leadership, which are as follows:

- defining the school's mission;
- managing the instructional program; and
- promoting a positive learning climate.

These dimensions are further divided into ten instructional leadership functions. For this study the second and the third dimensions which incorporate managing the instructional program and promoting a positive learning climate is of particular importance as the lesson study participative management model incorporates many of these elements.

The second dimension in particular consists of the dimensions of supervising and evaluating instruction, coordinating curriculum and monitoring student progress. The third dimension, deals with creating a positive school (college) climate, protecting instructional time, promoting professional development, maintaining high visibility, providing incentives for teachers and providing incentives for learning.

Surely, all these dimensions and components are crucially important for the lesson study-participative management model advanced by the researcher. The manager and all the lecturers (participants) in the LS process are actively involved, directly or indirectly, in managing and coordinating the instructional program. In the LS participative model this happens through identifying the goal; in our case identifying misconceptions in shape, space and orientation as well as monitoring student progress when observing students in the LS process. Furthermore, the LS management process also promotes and improves a positive college climate utilising the mechanisms of participative management, as one of the outcomes of participative management is positive transformation and lecturers taking ownership in terms of the lesson design.

The LS participative model also promotes the component of high visibility mentioned in the third dimension of the leadership model of Hallinger (2012). This comes about owing to the fact that the manager is a participant observer throughout the entire process of the LS process.

3.4 OUTCOMES OF LESSON STUDY THROUGH PARTICIPATIVE MANAGEMENT

There are many positive outcomes which accrue through the process of using LS through participative management (PM) at education institutions. Many of them are focused on the individual lecturer and students and others are focused on the organisation through contributions that are made by management and the participative nature of LS. This is as a result of the empowerment that takes place by lecturers, students and managers who together empower the organisation (TVET college).

In order to appreciate the outcomes of LS through PM, one has to appreciate the advantages and benefits of LS (above) and PM. According to Mataboge (2014), among others, the following are advantages of PM:

- It helps teachers discover new opportunities and challenges while enabling them to learn by sharing and combining knowledge. For example, members discovered the immense opportunity student-centeredness and problem solving offer in Mathematics lessons. Challenges were resolved very easily through pooling and sharing collective and combined knowledge of the group.
- It enhances the value of democracy, transparency and equity. Trust, respect for one another and freedom to make decisions were encouraged.
- It achieves organisational goals in terms of changing the organisational culture through participation and collaboration.
- It overcomes resistance to change and reduced stress, especially for management. Even though there was initial resistance, participants appreciated the value of LS even though LS challenged their conventional way of lesson planning, delivering lessons, observing students and reflecting on lessons.

- It allows management and lecturers to address aspects of curriculum management in terms of the implementation of policies thereby enhancing motivation and fostering collegial interaction. The team approach in LS made members realise that the prescribed curriculum is not always applicable in the manner in which it is structured and, through the LS process it allowed participants and managers to review sections of the curriculum which have an effect on curriculum management for managers and curriculum authorities.

Shared leadership within an organisation which is assisted by LS through PM, engenders the power of decision making in individuals and results in organisational empowerment (Smith, 2008:20). A further very important note made by Smith (2008:23), and one which is important for the present study, found that when teachers' (lecturers') participation is focused on instruction-related decision making, as in the case of LS, it was found that students' learning was influenced very positively because of the professional participation. It was therefore suggested that teams such as LS teams should focus on decisions about curriculum and instruction policies since it works to the benefit of students. In this LS process the researcher wishes to empower lecturers to be able to make decisions freely and not to be constrained by management. One way the researcher could achieve this through the LS process, was to take what was learned from the LS process as an input to make changes to the curriculum and therefore make changes to policies to gain what works best in the interest of the students.

In 'the principles of empowerment evaluation' by Fetterman (2005:42-72), ten evaluation principles are used to measure the success of any participative project undertaken by education institutions. These principles are:

- Improvement,
- Community ownership,
- Inclusion,
- Democratic participation,
- Social justice,

- Community knowledge,
- Evidence-based strategies,
- Capacity building,
- Organisational learning, and
- Accountability.

The principles above which were used to evaluate the success of the LS through PM, were improvement in teaching and learning, democratic participation in terms of trust and respect, social justice, capacity building, organisational learning and accountability in terms of responsibility toward students and responsibility toward lecturers.

According to Somech (2010), PM at education institutions also has other outcomes. The model developed by Somech using the contingency theory as the basis investigated the PM approach at education institutions via a transformational approach. It was also divided into managerial and teacher outcomes, namely, school outcomes such as innovation, organisational citizenship behaviour (OCB), and productivity; and on teacher outcomes: job satisfaction and strain.

Combining all the information above and drawing on Burghess and Robinson (2010), the following are outcomes of LS through PM:

- Increased knowledge of subject matter and instruction through a collaborative and participative approach;
- Formation of strong collegial networks with staff at the institution, across similar institutions and with management; and
- Stronger motivation and self-efficacy.

Drawing on the information above and the preceding theories, the following six outcomes were used to measure the impact of LS through PM in this study:

1. Improved organisational culture through collaboration and participation in LS

2. Better management of the ML curriculum through instructional leadership (Kuramoto & Shi, 2012)
3. Developing better teaching strategies
4. Stronger motivation and self-efficacy
5. Better delegation by managers to subordinates through the team approach and participation by managers in the process
6. Improved relationship between managers and subordinates
7. Enhancement of a positive school culture through the collaborative and participative culture
8. Champions of LS whole school (college) improvement and
9. Management coaching.

3.5 THE LESSON STUDY – PARTICIPATIVE MANAGEMENT MODEL

A model, which in this study is referred to as the *LS participative management model* is designed to depict the relationship between LS, participative management and collaboration. Participative management may be used as shared collaboration through democratic means as a vehicle to bring about improved teaching and learning using LS.

The model is diagrammed below:

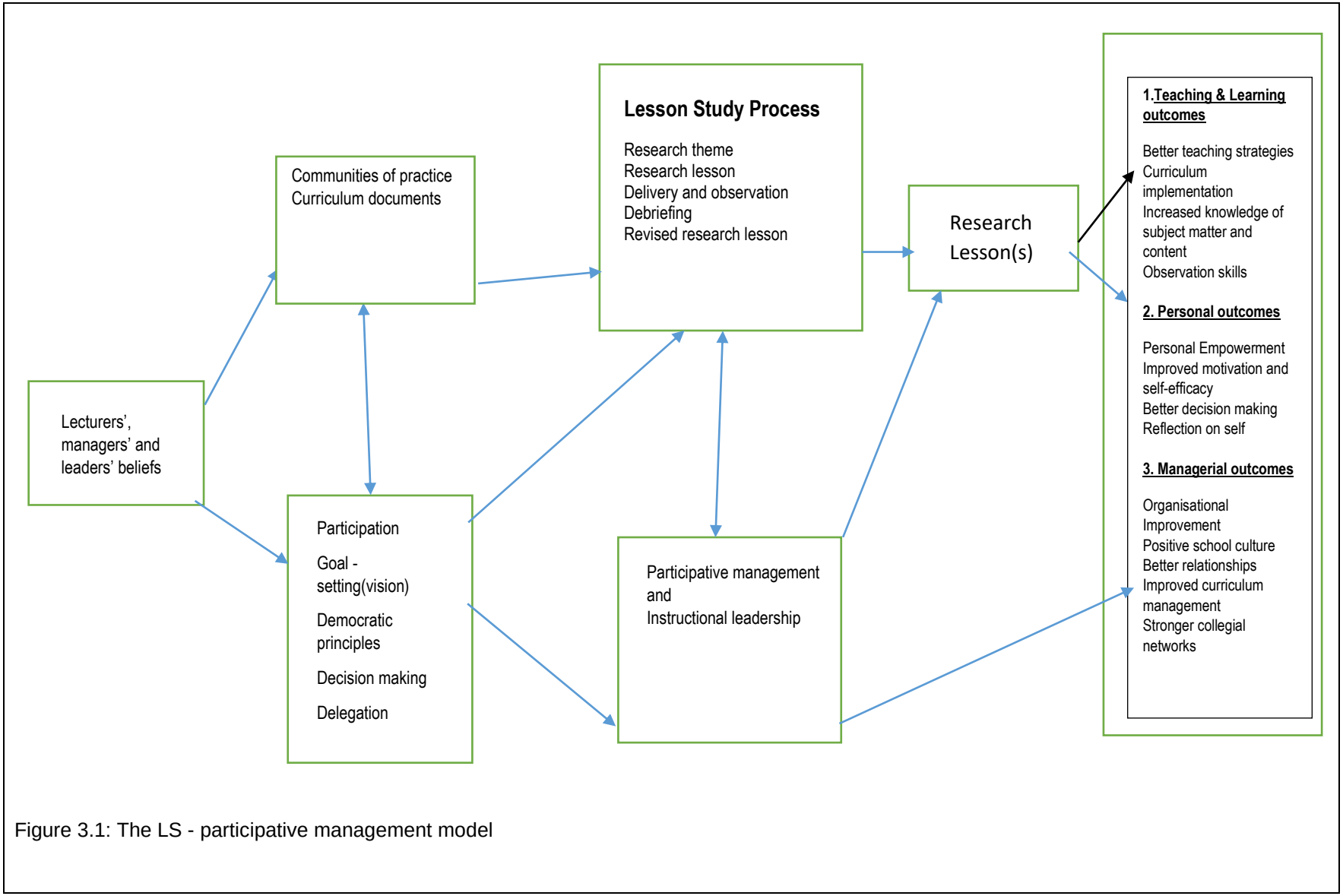


Figure 3.1: The LS - participative management model

3.5.1 Explanation of the LS participative management model

As mentioned before, according to Bandura (1977), teacher self-efficacy is the belief held by a teacher about his/her ability to teach effectively and this belief will determine whether he or she will be capable and successful in the outcome. What this implies for lecturers is that individuals are more inclined to attempt a task if they feel they are capable of success in terms of implementing a new curriculum, or a new teaching approach such as LS. This was evident, for example, when delivering both the first research lesson as well as the revised research lesson in this study by the different participants it was so willingly done as they had high confidence and believed in themselves to deliver a good lesson. Through observing the first participant delivering the first research lesson it resulted in a more willing approach in the next participant to deliver the revised research lesson.

Beliefs about management and leadership, for example, such as whether a lecturer believes that autocratic leadership is more effective than democratic leadership, influences his/her behaviour when it comes to how well s/he performs in a collaborative team. Similarly, the belief of a leader also influences his/her behaviour in relation to the team and the team's behaviour and actions. This also affects the effectiveness of whether teaching and learning has indeed improved through LS. The improvement in teaching and learning in turn again resulted in improved collaborative relationships, an improved LS process and improved teaching and learning in later cycles of the LS process. This was evident in this study as the firm belief by the researcher that the LS process will be a success and the researcher's positive attitude had a positive effect on participants as they reported an improved application of student-centred learning, for example.

Communities of practice established through collaborating with one another, lecturers, students and managers and applying pedagogical content knowledge in its entirety (knowledge of ML content, knowledge of students, knowledge of curriculum) and working with current curriculum documents play a major role in how one would

approach LS. Combined with the participative nature of the process of LS and through the lecturers working participatively with one another and with the manager delegating tasks in a democratic atmosphere and principles, better and improved decision- making results. The result of this feeds into the process of LS and following the different stages of LS, gives rise to a well-developed research lesson after the debriefing stage.

Improved teaching and learning result by following this process, such as improved teaching strategies, curriculum implementation, increased knowledge of subject matter and content and observation skills. The personal outcomes emanating from this process are personal empowerment, improved motivation and self-efficacy, better decision making and self-reflection. As far as the managerial aspects of this process are concerned, it leads to organisational improvement and whole school (college) improvement, positive school (college) culture through a positive ethos, better relationships, improved curriculum management and stronger collegial networks.

3.6 CONCLUSION

The researcher started this chapter by discussing the importance of the theoretical framework in a study and mentioned the difference between a theoretical and conceptual framework. The researcher then discussed the most common theories underpinning LS, such as constructivism and CoP. Next, he mentioned the theories underpinning participative management, such as leadership theories, Hawthorne's theory, Maslow's theory and many more. The researcher then discussed the outcomes of LS through participative management and the outcomes which will be used in this study to analyse data. Finally, the researcher developed a LS participative management model and explained how it works.

In the next chapter the research approach, method, sampling and the data collection methods will be discussed.

CHAPTER 4

RESEARCH METHODOLOGY

4.1 INTRODUCTION

In the previous two chapters the researcher outlined the context of the study by providing the reader with a literature review and theoretical underpinnings on which this study is based. In this chapter the researcher outlines the methodologies used in this study by providing a rationale for each method used. This chapter discusses the research procedure and research methods and also provides details of the data collection methods used, describes the reasons for using the research site and sample and the rationale of using the sample. A brief description is also given of the participants used in the study. It describes the role of the researcher and how he fits into this study. Finally, it describes the ethical considerations which were pertinent to this study.

4.2 PURPOSE OF THE STUDY

The main purpose of this study was to explore lesson study as a management strategy to improve performance in Mathematical Literacy at TVET colleges. In order to improve performance in ML, lesson study was used specifically as a vehicle through which misconceptions about space, shape and orientation were identified and at the same time what influence, impact and improvement the presence of management would have on the LS process as well as on lecturers' instruction and instructional leadership and thereby improve performance in ML.

In order to examine and investigate the above issues the following question was posed:

How does lesson study as a management strategy improve performance in the topic of space, shape and orientation in ML at TVET colleges?

The intended sub-questions were:

a) How can managers use lesson study in the teaching of space, shape and orientation in TVET colleges?

b) How do managers perceive the use of lesson study in the teaching of space, shape and orientation?

c) What are the managers' contributions in lesson study when teaming up with lecturers in dealing with space, shape and orientation?

d) How can the lesson study model be modified to include managers in the lesson study team and the impact it has on the lesson study process?

Based on the above questions the objectives of the study were:

- To determine how managers can use lesson study in teaching space, shape and orientation in TVET colleges.
- To determine how managers perceive the use of lesson study in teaching space, shape and orientation.
- To determine what the managers' contributions are in lesson study when teaming up with lecturers in dealing with space, shape and orientation.
- To determine how the lesson study model may be modified to include managers in the lesson study team and the impact it would have on the lesson study process.

4.3 RESEARCH PARADIGM

As far as the research paradigm is concerned, De Vos et al. (2013:513) explain that a research paradigm is 'a framework, viewpoint or a worldview based on people's philosophies and assumptions about the social world and the nature of knowledge'. Since this research was undertaken and conducted in the participants' natural setting

and context and allowed for modifications while the research was being conducted, an interpretivist paradigm was considered as appropriate (Harsono, 2016:54-55).

Furthermore, according to Saunders, Lewis and Thornhill (2009:116), the challenge here is to enter the social world of our research subjects and understand their world from their point of view. Educational management provides a function of a particular set of circumstances and individuals coming together at a specific time. Another reason why an interpretivist paradigm was suitable is that the experiences of participants were subjective, and through the dialogue of participants and between participant's multiple perspectives, deep real meanings were uncovered. Interviews with students after the first and second cycles of the LS process and interviews with participants after the second cycle of the LS process assisted with uncovering multiple perspectives and deep real meanings.

4.4 RESEARCH DESIGN

According to MacDonald and Headlam (n.d.:61), action research is 'learning by doing' which means a group of people identify a problem, do something to resolve it, see how successful their efforts were and, if not satisfied, try again. Action research is known by many other names, including participatory research, collaborative inquiry, emancipatory research, action learning, and contextual action research, but all are variations on a particular theme.

Furthermore, action research develops through the self-reflective spiral: a spiral of cycles of planning, acting (implementing plans), observing (systematically), reflecting and then re-planning, further implementation, observing and reflecting (Cohen, Manion & Morrison, 2007:300).

Cohen, Manion & Morrison (2007:303) further declare that action research consists of the following cyclical steps:

1. strategic planning;
2. action, i.e., implementing the plan;
3. observation, evaluation and self-evaluation;
4. critical and self-critical reflection on the results of points 1–3 and making decisions for the next cycle of action research.

Analysing the few paragraphs above, one can clearly see that it contains all the elements of LS, such as setting a goal (identifying a problem), doing something (lesson plan), evaluation (lesson observation), reflection (debriefing) and re-planning (revised lesson) and starting the cycle all over again. In this way the above steps coincide with the cyclical steps of LS.

In view of the above position, this present research study therefore falls under the action research design since the process of LS contains all the elements and activities of action research, being participative, collaborative, reflective, cyclic and happening in the context of the classroom and not outside the classroom as most professional development programs offered by education departments do. Furthermore, in this study, LS also becomes a vehicle through which the power of participative management within collaborative groups can be identified, enhanced and used as a management strategy to improve performance at TVET colleges.

According to Dickens and Watkins (1999:127), action research remains an umbrella term for a host of activities intended to foster change on the group (implementing LS at a college), organisational (participative management and decision making), and even societal levels. It further underscores the fact that organisational action research involves teams who address deep-rooted organisational issues through recurring cycles of action and reflection. It was also relevant to use action research as a design to incorporate management strategy to improve performance in space, shape and orientation in Mathematical Literacy.

In connection with the above the emancipatory interest which guides action research can also be a powerful tool to emancipate people from obstacles and constraints in achieving educational objectives (Coe, 2010:66). Furthermore, participative management and decision making are essential elements of LS and therefore LS cannot take place without the collaborative nor the participative aspect of LS being present, especially when the manager becomes part of the process albeit, in an observatory role. Decision making is delegated to the participants in the LS process itself when deciding on the goal, planning and observing. Therefore, PM is a function embedded in LS and LS cannot be successful without implementing PM. Hence, action research is also appropriate to be used in cases where an organisational change is to be made, such as through the LS - PM model.

4.4.1 Research design and methodology

Research Paradigm

De Vos et al. (2013:513) qualify a research paradigm as ‘a framework, viewpoint or a worldview based on people’s philosophies and assumptions about the social world and the nature of knowledge’. An interpretivist paradigm was considered, since the experiences of participants were subjective and multiple perspectives and deep real meanings were attached to the dialogue by the participant. Furthermore, an interpretivist paradigm was considered as this research was undertaken in the participants’ natural setting; that is, in the classroom of the lecturer and in the setting of students’ own environment, which made an interpretivist paradigm appropriate (Harsono, 2016:54-55).

Research design

Action research as a methodology of the qualitative research approach is an emergent, highly participative and collaborative type of research which connects very well with the process of LS in that it allows for the researcher to become a facilitator of a team which will design and be part of the outcomes of an action research process, called LS (O’Leary, 2004:98). The same author defines action research as ‘a research strategy

that pursues action and knowledge in an integrated fashion through a cyclical and participatory process. In action research, process, outcome, and application are inextricably linked'.

It generally involves the identification of practical problems (the goal in LS) in a specific context (classroom) and attempts to seek and implement solutions within that context. Action research is often used in workplaces where the ownership of change is a high priority or where the goal is to improve professional practice (change in the way we teach). It is also considered an effective strategy when there is a strong desire to transform both theory and practice.

Research approach

According to Kothari (2004:5) there are two basic approaches to research, namely quantitative and qualitative. The qualitative approach to research is concerned with subjective assessment of attitudes, opinions and behaviour and is a function of the researcher's insights and impressions. Since the LS process required the researcher to observe behaviour, attitudes and the insights of the participants (lecturers and students), the study therefore followed a qualitative approach.

4.4.2 Research site and participants

Research site

The research took place at one of the campuses of the TVET college where the researcher is an education specialist, but not where he has a power relationship; in other words, where the lecturers do not report to him and where there is no supervisor-subordinate relationship. The researcher coordinates the ML curriculum across all the campuses of this particular college. ML is taught in the Safety and Society program of the NC(V) curriculum at this campus.

Sample size and participants

According to De Vos et al. (2013:214, 223-224), a sample comprises a subset of the population considered for actual inclusion in the study and because it is not possible to study the entire population owing to time constraints and cost, a sample is selected. Furthermore, according to the recommendation of Burghess and Robinson (2010:20), the number of participants for LS might be four or five, but three would be possible. Hence, for this study, four lecturers were used as participants in this study.

4.5 PILOT STUDY

A small-scale pilot study was conducted before the main study which consisted of two participants, both lecturers in ML at a different campus to where the main study was conducted. The purpose of the pilot study was to determine and ascertain the practicality and appropriateness of firstly, the method of research, and secondly, the instrument and the time factor. According to Ismail, Kinchin and Edwards (2018), a pilot study assists researchers in testing how likely the research process is to work in reality, to help them decide how to best conduct the main research study.

The pilot study was conducted over roughly two months with the Level 3 Hospitality students which commenced with a presentation on LS followed by three daily meetings of roughly an hour in a week which covered the research theme, and two meetings on planning of the research lesson. This was followed by two weekly meetings with the participants on planning of the research lesson. The research lesson was finalised the week thereafter. After the research lesson had been delivered, a debriefing was held, and two more meetings were held to review and eventually improve the lesson in the second cycle. Hence, one complete LS cycle and a second partially completed cycle, with only the revised lesson in the second cycle which was not delivered owing to time constraints.

Interviews with the two participants were held on two consecutive days, digitally recorded and then transcribed verbatim. The purpose of those interviews was firstly to test the language used in every interview question in terms of understanding and

substance, and secondly, to collect qualitative data and to see whether answers were sufficient to address the research questions.

The documents which were produced during the pilot study were:

- Observation sheets
- Students' answer sheets
- Meeting notes
- Two research lessons, one from the first cycle and the revised research lesson from the second cycle
- Researcher's journal

4.6 RESEARCH APPROACH

According to Kothari (2004:5), there are two basic approaches to research, namely quantitative and qualitative. The qualitative approach to research is concerned with subjective assessment of attitudes, opinions and behaviour and a function of the researcher's insights and impressions. Since the LS process required the researcher to observe behaviour, attitudes and the insights of the participants (lecturers and students), it therefore followed a qualitative approach. Qualitative data was collected from direct observation of students by the participants, recorded on observation templates or own notes and semi-structured interviews with participant lecturers and students in the different phases of the LS process. These methods allowed the researcher to understand, ask for explanations, explore and discover the feelings and experiences of the participants. It therefore provided the researcher with rich descriptions of participants' knowledge and experiences.

4.6.1 Research site

Choosing a site is a negotiation process to obtain freedom of access to a site that is suitable and feasible for the research problem in terms of resources, time, mobility and skills. After a site has been identified the usual permission to gain entry is facilitated

through the request for permission to conduct the research (McMillan & Schumacher, 2006:319, 342). This was achieved by obtaining permission from the principal (CEO) of the college where the research was conducted. After obtaining permission, the approval to conduct the research was granted.

The site (campus) that the researcher initially identified to conduct the research did not materialise for three reasons. The first was that a lecturer whom the researcher intended to use as a participant in LS left the company at the end of 2017 and a few non-permanent emergency appointments were made on whom the researcher could not depend. The second reason was that another ML lecturer from the same site refused to participate as her health was failing her.

The third reason why the initial decision did not materialise was that after the first submission of the researcher's ethical application, the ethical board of the university objected to the power relationship which existed between the researcher as education specialist and his lecturers at this particular campus. Because of this fact it was advised that the lecturers' participation might not be voluntary. It was therefore decided to conduct the research at a campus of the college where the researcher is not an education specialist and therefore does not have a power relationship with the lecturers, but merely being a Mathematical Literacy coordinator across the college in terms of curriculum support.

Hence, it was decided to conduct the research at another campus (site) which was close to the campus where the researcher is based as an education specialist. Ease of access to lecturers, students and managers was the main reason as a rationale for choosing that campus at the time.

The NCV programs where Mathematical Literacy is a fundamental subject at this particular campus is the Safety and Society program and many of the students who attend this college come from a disadvantaged section of the Western Cape and struggle with both Mathematics and Mathematical Literacy.

4.6.2 Sample size and participants

According to De Vos et al. (2013:223-224), a sample comprises a subset of the population considered for actual inclusion in the study. De Vos et al. (2013:214) further state that since it is not possible to study the entire population because of time constraints and cost, a sample is chosen because it is more feasible. It is further noted by McMillan and Schumacher (2006:127) that when the sample size is determined, a sufficient number must be obtained in order to get credible results.

The subject ML is offered at four of the campuses of the college where the researcher is an Education Specialist for Mathematics and Mathematical Literacy. Three of the campuses offer Mathematics and Mathematical Literacy, while one campus offers only ML. Of the four campuses where ML is offered, there are two campuses where there are only two lecturers offering ML and the rest have three to four lecturers offering ML. This is to effectively optimise the deployment of lecturers and alignment with the college and campus timetables.

At the campus where this study was conducted, there were four lecturers who taught ML in the NCV curriculum and in the Safety in Society program. In line with the recommendations of Burghess and Robinson (2010:20), the number of participants for a LS team could be four or five, but three would be possible. They further state that if there are only two, there is no balance in views expressed and if there are six or more, there is not enough time for everyone to participate in the planning and review sessions; it would be difficult to release such a large number of teachers without having a negative impact on instructional time. Hence, the sample size of four participants was sufficient for this study and would give a balanced view as it is just above the minimum and also below six. Taking all this into consideration, the sample size of this study therefore involved four participant lecturers as indicated in Table 4.1.

Table 4.1: Participant information

Participant Lecturer	**College role**	**Lesson study role**
PL1	Lecturer in ML with seventeen years' teaching experience. Also has experience teaching Mathematics in different TVET college programs.	Participant and observer
PL2	Lecturer in ML second consecutive year. Twenty years teaching experience in other subjects and also taught ML for three of years at the college before.	Participant and observer
PL3	Lecturer in Mathematical Literacy (first year teaching ML) but also taught Mathematics for three years in other programs.	Participant and observer
PL4	Lecturer in Mathematical Literacy (first year teaching ML) but has also taught Mathematics for eight years at this college.	Participant and observer

To date (2019), when this research was conducted, Lecturer PL1 has extensive experience lecturing ML for seventeen years since the introduction of ML at TVET colleges, while also having experience teaching NCV Mathematics and Mathematics to the report 191 NATED trimester programs. Lecturer PL2 is lecturing ML for the second consecutive year, but has many roughly twenty years' teaching experience in a combination of subjects such as Computers and Life Skills and had also taught ML for something like three years before. Both PL3 and PL4 are teaching ML for the first time in 2019, but had taught Mathematics before at the college in other programs. Compared to PL1 and PL2, they do not have that many years of teaching experience; hence the sample is quite representative in terms of years of teaching experience providing for novice and expert experience. Purposeful sampling was therefore used in this study as the researcher was interested in individuals with certain interests and characteristics

and therefore with a rich amount of knowledge to assist the study (Johnson & Christensen, 2014:364).

It is further suggested by Burghess and Robinson (2010:20) that for LS to be effective and successful, teachers who teach the same level should be used as participants in the LS group and that teachers see different groups in the LS cycles as far as observation is concerned. Hence, students who were part of this study consisted of the Level 2 NCV students of both lecturers PL3 and PL2 and both lecturers had the opportunity to see different students in the observation stage of LS.

Every class of students had roughly 30 Level 2 students and the first research lesson delivered to the students of lecturer PL3 and the case students were observed. The second LS cycle was delivered to students of lecturer PL2 and the case students were observed in this cycle. The case students were selected based on their performance, especially on baseline tests and from their performance in their assessments and since they continuously struggle with this section of the work.

Every observer (participant) was appointed to observe 3 case students. Since the lecturers knew the weaknesses of their own students, they selected the case students on the basis of very weak, weak and moderately weak. All the participants were briefed on the background of the entire class and specifically on the case students before the LS commenced.

4.7 DATA COLLECTION PROCEDURE

Data which is collected must be objective to provide for the interpretation of results obtained (Singh, 2006:212). Ways of obtaining data are through the tools and instruments of group discussions, interviews, documents, observation and field notes. Singh (2006) also points out that the researcher must know how much and what kind of data collection will take place and when.

Data collection in this study commenced when the researcher held his first meeting in terms of a presentation with the participant lecturers to explain the process of LS. In this

same meeting a presentation was made on the literature as far as misconceptions in Mathematics is generally concerned, and specifically around space, shape and orientation. The researcher was guided here by the theoretical foundations discussed in chapter 3. The purpose of this activity was to make participants aware of on what to focus in their observation phase of the LS process. In this meeting mention was also made about participative management and how it fits into the LS process as well as the purpose of PM for this study. Minutes of this meeting were documented and digitally recorded.

Secondly, at the commencement of the first cycle of LS, a group discussion with the four participants chaired by the researcher was held to decide on the section of space, shape and orientation that was the most appropriate to be used in the research lesson to highlight the areas the students struggle with. This discussion was also digitally recorded by the researcher and careful notes were made by the researcher on which sections students struggle with.

A group discussion was held to collaboratively plan the research lesson with activities in mind to assist the case students and to plan around the case students. This phase lasted for about 50 minutes to an hour every week. The researcher guided the process and also gave input into the research lesson. Minutes of the discussion were documented and digitally recorded by the researcher. The product of these stages of the LS was a research lesson collaboratively developed in the form of a lesson plan to be used in the next step of the LS process.

In the delivery of the research lesson one participant was chosen randomly to deliver the lesson while the other participants observed the case students in terms of how they performed, behaved, discussed and solved problems around space, shape and orientation according to the activities in the research lesson. Participants were given a copy of the research lesson and their observations and reflections were recorded on pre-designed observation templates or own reflection notes, as detailed as possible by following the lesson plan as a guide. The duration of the observation was the same as the length of a period which at this college is about 50 minutes.

Photographs to show how students worked and deliberated were taken and students' answer sheets were produced. The researcher observed students and recorded notes. The researcher also made his own notes on the observation sheets by observing case students and made notes on performance of this stage of the process. The researcher also carefully observed the role management could play, what use they could obtain from that and what could be contributed.

Immediately after the delivery of the first research lesson, a debriefing session in the form of a group discussion was held with the participants in which participants' observations were discussed in terms of how students performed and behaved and how the research lesson could be improved. The researcher recorded the minutes of meetings and digitally recorded the discussions. Interviews were conducted with some of the students to whom the research lesson was delivered and digitally recorded.

The next cycle (or the second cycle) of the LS process involved a group discussion in which the research lesson was reviewed and a new reviewed research lesson was planned and developed collaboratively by the four participants. The researcher documented minutes of the discussion and digitally recorded the discussions. A revised or reviewed research lesson plan was the result of this phase of the LS process.

In this second cycle of the LS process the reviewed research lesson was delivered by a different participant to a different class of NCV Level 2 students and the other three participants observed the case students and the participants recorded their observations on the observation sheets or made their own notes and reflections. Participants were given a copy of the revised research lesson and their observation sheets were collected. The researcher also observed students and recorded notes.

Immediately after the revised research lesson had been delivered, an interview was conducted with randomly selected students including case students; a debriefing session was held with the participants, and a semi-structured interview was conducted with each of the four participants All these interviews were digitally recorded.

A table to indicate the relationship between the LS stage, data collection method and the product which will be used to analyse the data:

Table 4.2: LS stage, data collection method and the product

Stage of the LS cycle	**Data collection method**	**Product for analysis**
Research lesson planned collaboratively	Group discussions/meeting	Minutes of meetings Research lesson plan Transcribed digital recording Field notes
Delivering the research lesson	Observation	Observation sheets Photographs Students' work (answer sheets) Field notes
Revising the lesson (debriefing)	Group discussion	Minutes of meetings Revised research lesson plan Transcribed digital recording Field notes
Delivering the revised research lesson	Observation	Observation sheets Photographs Students' work Field notes

4.8 DATA COLLECTION METHODS

According to O'Leary (2004:85), research methods are the techniques used to collect data, which includes such techniques as interviewing, surveying and participative observation, while the research design is the plan for conducting the study that includes all of the devices that will be used to help collect the data, such as questionnaires, observation checklists, interview schedules.

The data collection methods used in this study may be summarised as: observations, group discussions, document analysis, interviews and field notes. When more than one method of data collection is used, it enhances triangulation and improves the trustworthiness of data (UNISA, 2002:56).

4.8.1 Observations

Observation was the principal method of data collection employed in this study. Spradley (1980) mentions in Creswell (2012:212) that observations represent a frequently used form of data collection, with the researcher being able to assume different roles in the process. Observation is the process of gathering information first-hand by observing people at a research site (Creswell, 2012:213). When one is more interested in the behaviour than in the perceptions of individuals, observation is the best approach to gather the required information (Kumar, 2011:134). Kothari (2004:96) further highlights that one benefit of using observation is that it "relates to what is currently happening; it is not complicated by either the past behaviour or future intentions or attitudes". Subjective or social desirability bias and memory problems are therefore eliminated.

According to O'Leary (2004:172), the different roles a researcher can assume in the observation process may be anything from removed to immersed observation. Although most of the observation was conducted by the participant lecturers observing the case students, the researcher was neither totally removed nor a full participant. The researcher observed the process and also observed the lecturers, students and case students and made field notes, while being as objective as possible at the same time.

While the research lesson was delivered by one participant (any one of the four lecturers), the other three participants observed the lesson using the lesson plan as a guide and focusing their attention on the entire class, but more specifically on the case students assigned to each participant. The lesson which was delivered concentrated on 2D shapes involving perimeters and areas and the participant observers had to observe how students perform in terms of what they write and how these problems were solved. Observation notes were made on students' behaviour on the observation templates while the lesson was conducted as well as while activities were performed by students. Careful notes were made on what the students talked to one another about, what actions they performed on their pages and how they tried to solve the problems and activities given. What was expected students would do (their anticipated responses) and what they actually did were recorded by participants on their templates. However, they were also encouraged to make their own reflective notes.

4.8.2 Interviews

An interview is a data-collection method in which an interviewer, who in most cases is the researcher, asks questions of an interviewee (the research participant). Qualitative interviews which provide qualitative data allow the researcher to collect in-depth information about a participant's thoughts, beliefs, knowledge, reasoning, motivations, and feelings about a topic (Johnson & Christensen, 2014:316-324).

In this study the four lecturers who took part in the LS process and a selected number of students, which included the case students, were interviewed. Although a semi-structured interview schedule was utilised it was only used as a guide to keep the interview on track and allowing the researcher to pose and probe more in-depth questions as the need arose. All the interviews conducted were face-to-face, digitally recorded on the researcher's laptop and later transcribed verbatim.

Two semi-structured interviews with the students were conducted. The first one took place after the first cycle of the LS process and the second after the second cycle of the LS process in the lecture room where the research lesson was presented. This was to find out what the students had learnt and what could be improved and also what they

could do better and improve on. The semi-structured interviews with the participant lecturers were conducted after the second cycle of the LS process.

4.8.3 Group discussions

Group discussions in the form of meetings took place at the following points in this action research: in the first meeting when the LS process was explained and introduced; when the first cycle commenced in the section of the topic to be delivered was decided on; collaboratively planning and developing the first research lesson which consisted of several meetings; debriefing session after and in the second cycle which consisted of the planning and developing of the revised research lesson. The section of the topic which was decided on was 2D perimeters and areas. Careful minutes of these meetings were recorded and digital recordings were made.

4.8.4 Documents

Document analysis refers to the collection, review, interrogation, and analysis of various forms of text as a primary source of research data (O'Leary, 2004:183). According to De Vos et al. (2011:388), document analysis enables the qualitative researcher to investigate people, events and systems in depth by analysing written material.

Various documents were produced during the LS process, from the beginning to the end. Some were produced through observations, group discussions and field notes. The first document that was produced was the participant lecturers' journals which were produced after each meeting in which they were asked to journal and document their feelings, experiences and what went well; what could be improved; and what they learnt. The second document produced was the work in progress research lessons after every meeting which culminated in the first research lesson after several group meetings. These research lessons and the research lesson after the first LS cycle were generated collaboratively by the participants of the LS group. A second revised research lesson was produced following the same procedure as the first LS cycle after input from the debriefing session had been taken into consideration.

The second document which was produced was the completed observation sheets completed by every LS participant during and after the first research lesson had been delivered as well as during and after the second revised research lesson presentation. The third document produced was the researcher's own journal (field notes). Photographs were taken and students' work in the form of answer scripts on activities given during the delivery of the research lesson and the revised research lesson from the second cycle were produced and considered in the data analysis stage.

Making notes and writing down essential information throughout the entire LS process was an essential activity at all levels in this study. Documents emanated from the researcher's own writings started with minutes from meetings, his own observations when deciding on the topic to address in space, shape and orientation; observations when designing the research lesson and reflections on it and minutes from debriefing sessions as well as reviewing research lessons and field notes when observing students when the research lessons were presented. There were also notes made by participants on student observations, reflections and debriefing notes and lesson plans and planned activities to be given to students. Documents which were analysed consisted of the minutes of meetings, the researcher's field notes, participant journals, completed observation templates and schedules, lesson plans and activities.

4.8.5 Field notes

Throughout the entire lesson study process, the researcher recorded observations in terms of what happened, how the participants behaved, how students performed, dates and exact activities which took place. These included the researcher's minutes of meetings, reflections, daily logs and journals of what was happening and what transpired.

The researcher asked participants to record their own notes and reflections on the entire LS process. The notes they documented were on issues such as their own insights, impacts on student learning and on instructional practices and leadership.

The researcher's field notes and reflections focused on issues such as how students were behaving and learning; his presence and whether participative management was

bringing a positive improvement to the LS team; and how his visibility improved a positive climate among the staff; and improved instructional leadership according to Hallinger (2012).

4.9 THE ROLE OF THE RESEARCHER

The roles the researcher had to play in this study were varied and consisted first of all of informing the participants in a general monthly meeting of his intention to conduct this study. Next the researcher gave a presentation on misconceptions in Mathematics and ML as well as the LS process and how it is conducted. In this presentation the researcher also mentioned other studies and how they were conducted.

Furthermore, the researcher's role consisted of designing semi-structured interview questions; designing observation templates; deciding on the topic for the research lessons; and giving input in designing the research lessons with the participants collaboratively; conducting interviews; observing lessons and students and managing, directing and supervising the LS process. Although the researcher only knew what LS is from the literature studied, he did not portray himself as an expert in LS; he only facilitated it. He served as the content expert through his knowledge of teaching strategies in teaching Mathematics and ML.

While his role was primarily that of researcher, he was not a full participant nor a passive participant. He was merely a participant observer. He took part in all discussions and decisions and gave input from his position as being the 'knowledgeable other' and, although he played the role of a manager, he tried his utmost not to let his position as a manager influence the process, dominate or take over the process, but simply to observe the LS process and what impact it had on instructional leadership, had a manager been part of the process and what managers can use and contribute.

Although the researcher is a manager at the college where the research was conducted, he refrained from letting opinions and perceptions impact unduly on the study. Instead, the researcher was guided by the data and not by his personal opinions and perceptions on the research topic. Perhaps it would be worthwhile to see that from this study, the participants developed beyond just being lecturers; also acquiring some

managerial skills which they would have displayed in the next levels of using the lesson study model.

4.10 DATA ANALYSIS

De Vos et al. (2013:249) state that the purpose of data analysis is to convert the data which was so gathered into an intelligible and interpretable form to draw certain conclusions.

Data gathered through the different data collection methods described above such as observations, documents and interviews will now be described. Although it is suggested that data collection and data analysis should happen simultaneously, it did not happen in this study. All the data collected in this study were qualitative and all the data gathered through the different techniques were analysed by identifying the emergence of dominant themes and then further coding them into meaningful categories.

4.10.1 Observations

Observations were conducted by the participants and the researcher when the research lesson was delivered in both cycles 1 and 2. These observations, recorded on observation sheets and the participants' and researcher's own notes were read several times by the researcher; common themes were placed in categories and hand-coded by focusing especially on the errors students committed, and the misconceptions which were identified. How students behaved and discussions they had with one another while wrestling with the problems were also seen as categories.

4.10.2 Interviews with participants and students

4.10.2.1 The interviews with students and case students

Although the researcher's intention (as stated in his ethics report) was to have a first interview with the participants after the first cycle, the researcher realised that sufficient information would not be obtained from participant lecturers in terms of issues regarding curriculum, management, empowerment and participative management.

The first interview with students, which was randomly chosen and which included case students, took place after the first LS cycle, immediately after the research lesson had been delivered in the lecture room where the lesson was presented. This interview was digitally recorded on the researcher's laptop and transcribed verbatim. In the data analysis process this interview was listened to several times to identify categories and themes.

The second interview with students took place after the second cycle of the LS, also immediately after the revised research lesson. Since this revised research lesson was with a different group of Level 2 students, the interview was with a different group of students. This interview was also digitally recorded and transcribed verbatim in order to identify categories and common themes. Interviews which were held with the students were held with the students together to have a collective response from students in terms of what they now know that they did not know before, as well as the implication of LS and how different the research lesson was from previous lessons.

4.10.2.2 The interviews with participant lecturers

The interviews with the four participants were conducted after the second LS cycle and after the debriefing of the second cycle had been completed. These interviews were conducted over two days consecutively with all the four participants. A semi-structured interview schedule (see Appendix R) was followed which provided the researcher with the opportunity for some flexibility to probe participants and ask follow-up questions. In this interview, the researcher asked participants questions on changes in their teaching practice pertaining to this section; their experiences in participating in a LS process; and questions related to empowerment, management and transformation for TVET colleges; the future of LS at TVET colleges; and challenges experienced.

These interviews were digitally recorded on the researcher's laptop through the audio recording facility and transcribed verbatim and manually. The transcripts were then read and re-read a second and a third time and as dominant themes started to emerge, were hand-coded and placed into broad categories to align with the research questions and the underlying theories mentioned in chapter 2 (Literature Review).

The LS process took place over roughly seven months, from late February to the end of August 2019, excluding two vacations of two and three weeks respectively. Fourteen weekly LS meetings were held which consisted of collaborative research lesson design, debriefing and delivery of the research lesson and observation for two cycles. In this interview, the researcher asked participants questions on changes to their teaching practice pertaining to this section compared with their previous teaching practice and their overall experiences in participating in the LS process.

4.10.3 Document analysis

All documents generated through this research, such as minutes of meetings, work-in-progress lesson plans, the research lesson and the revised research lesson, field notes by the researcher in the form of daily logs and journals, debriefing notes and reflection notes by participants were collated, read and re-read several times when dominant themes and categories were identified in terms of misconceptions, instructional leadership, participative management and pedagogical knowledge as outlined in chapter 2.

4.10.4 Photographs and students' work

Students' work that was done from the activities (answer sheets) given in both the research lessons (research lesson and revised) were collected from the case students and analysed for methods followed. These were then analysed to ascertain which errors and therefore which misconceptions underlay those errors. The students' work was also analysed to see whether any improvements were made in determining answers using the LS approach.

Photographs of the class doing the work and activities during the delivery of the research lesson and reviewed lesson, and especially of the case students, were taken and analysed for their behaviour in terms of students' behaviour, thinking and talking. The different photographs which were taken while lecturers were presenting the lesson and participants observing were mainly used to triangulate and as a 'paper trail' of events which took place.

4.11 ETHICAL CONSIDERATIONS

Before the data had been gathered for this study, that is, before research started, permission was sought and the researcher was granted ethical clearance from the university where the researcher studied (see ethical clearance certificate in appendix F). Permission was also sought and granted from the Department of Higher Education and Training, from the Principal (CEO) of the TVET college where the research was conducted, from the participants in the LS process, the students who were observed and parents where students were under the age of 18.

Participants were ensured anonymity and confidentiality for participating in the study and no names were used in the study to protect their identity. Whenever reference was made to a participant, pseudonyms were given. Information on the purpose of the study, the nature of their participation and the fact that they could withdraw at any time, either before the study or during the study, was clearly communicated to the participants. Participants including lecturers, students and parents signed consent forms to confirm their agreement to participate in the study.

The clearance certificate from the university, letters to the CEO and to participants and parents as well as the returned consent forms are attached as appendices at the end of the thesis.

4.12 RELIABILITY AND VALIDITY

McMillan and Schumacher (2006:324) define validity as the degree of congruence between the explanations of the phenomena and the realities of the world. In other words, validity implies that the interpretations have mutual understanding between the participant and researcher.

Reliability, according to Kumar (2011:183), occurs when a research tool is consistent, stable, accurate and reliable; the greater the consistency and stability, the greater the reliability. If repeat measurements on a test under the same conditions produce the same results, the instrument is said to be reliable.

In this study, the first threat to validity was due to the small sample of four lecturer participants. The researcher ensured the validity of the data by means of multiple data sources (interviews, observations, lecturer notes and journals) in which triangulation was applied. Since the LS process spanned two college terms, over the time that space, shape and orientation is done, a prolonged opportunity was granted for detailed interactions.

To avoid a threat to voluntary participation, a campus of the college was chosen where the researcher does not have a supervisory-subordinate relationship or position. The second way to ensure validity would be to ensure that the researcher's own bias would not interfere in the data collection processes. Every participant interviewed would also be given the opportunity to verify the transcripts, documented responses from discussions and debriefing sessions.

4.13 CONCLUSION

In this study the research design used was an interpretive approach utilising an action research design. A qualitative approach was used with the research site at one of the campuses of the college. Four participants were selected to be part of the LS team which made up the sample of the research as well as case students who were observed as part of the stage of LS.

The data collection procedure was described in detail as well as the data collection methods of observations, interviews and group discussions used in the study, after which the data analysis was described followed by the ethical considerations. The findings of the data collection methods discussed in this chapter will be presented in chapter 5.

CHAPTER 5

FINDINGS

5.1 INTRODUCTION

The purpose of this research was to determine how lesson study as a management strategy can improve performance of Mathematical Literacy students in the topic of space, shape and orientation in Mathematical Literacy at TVET colleges. In order to meet the main purpose of the research, the researcher sought to answer the following research questions:

- To determine how managers can use lesson study in teaching space, shape and orientation at TVET colleges.
- To determine how managers perceive the use of lesson study in teaching space, shape and orientation.
- To determine what the managers' contributions are in lesson study when teaming up with lecturers in dealing with space, shape and orientation.
- To determine how the lesson study model may be modified to include managers in the lesson study team and what impact it has on the lesson study process.

The LS process in this research study consisted of a small-scale pilot study followed by the main study. The pilot study consisted of one complete cycle followed by an incomplete second cycle. The incomplete second cycle ended with designing the revised research lesson, but owing to time constraints did not materialise in delivery of the revised lesson. Semi-structured interviews were conducted after the incomplete second cycle with the two participant lecturers to gauge the participants' experiences and to improve the main study.

The main study consisted of two complete cycles which included collaborative goal setting, investigation of the Level 2 ML curriculum and planning the research lessons. This was followed by the presentation of the research lessons and observations, debriefing and reflections on the research lessons together, and revising and improvement of the research lessons. The LS process also included two interview sessions with students, one after the first research lesson, and one after the second revised research lesson. This was followed by a semi-structured interview with all four participants who participated in this research.

The sources from which the findings were gathered were transcripts of research lesson study sessions, which took place over roughly seven months, from late February to the end of August 2019, excluding two vacations of two and three weeks respectively. The transcripts consisted of research lesson meetings and discussions, research lesson observations, debriefing and reflection on the lessons, two focus group interviews with students who were randomly chosen and case students after the delivery of each research lesson, lecturers' and the researcher's weekly reflective journal entries and semi-structured interviews with the four participants after the second cycle.

The themes identified were as follows:

- Opportunity to improve lecturers' experience in the content knowledge of space, shape and orientation.
- LS provided lecturers and managers with reflection on instruction and instructional leadership.
- Creation of an open organisational culture through collaboration and participation in LS leads to organisational effectiveness
- Personal and professional improvement and empowerment of lecturers
- Managers' role, contributions and participation in the use of LS at TVET colleges
- Challenges lecturers and managers encountered in conducting LS at TVET colleges

- The future of LS in the TVET sector using the model of management involvement
- The need for the participation and involvement of management in LS.

5.2 THE DATA ANALYSIS PROCESS

Data analysis had already commenced when the researcher started with the research component by jotting down ideas for highlighting possible themes. This continued throughout the process of LS until the last interview with the participants and beyond.

After all the interviews with the four participants and the randomly chosen students had been conducted, the interviews were listened to by the researcher and then transcribed verbatim. This was followed by a process of reading and re-reading the transcripts. The same process of listening to was followed with the meetings as well as the debriefings after the delivery of the research lessons. This was then transcribed and read for important information. The notes recorded and documented from the researcher's journals and participants' journals were highlighted for important information in view of the coding process which started thereafter.

Initially 135 different codes were identified and eventually only about 90-100 of those codes were of significance. Through the process of careful thought, these 90-100 codes were divided into major codes, important codes, leftovers and other codes (McMillan & Schumacher, 2006:370-371). Then the process of identifying patterns and categories started which resulted in twelve categories. Through careful analysis and consideration of all the data, eight broad themes were identified (see above), each one with a few sub-themes which more or less corresponded with the categories referred to above.

A summary table of codes, categories, sub-themes and major themes is given below.

Table 5.1: Summary of codes, categories, sub-themes and major themes

Abbreviated Codes	Matching Categories	Sub-themes Summarised	Themes
Misc, err, Pyth, hyp, conf, chall,	Confusion Formula	• Challenges in teaching and learning regarding	Opportunity to improve lecturers' experience in

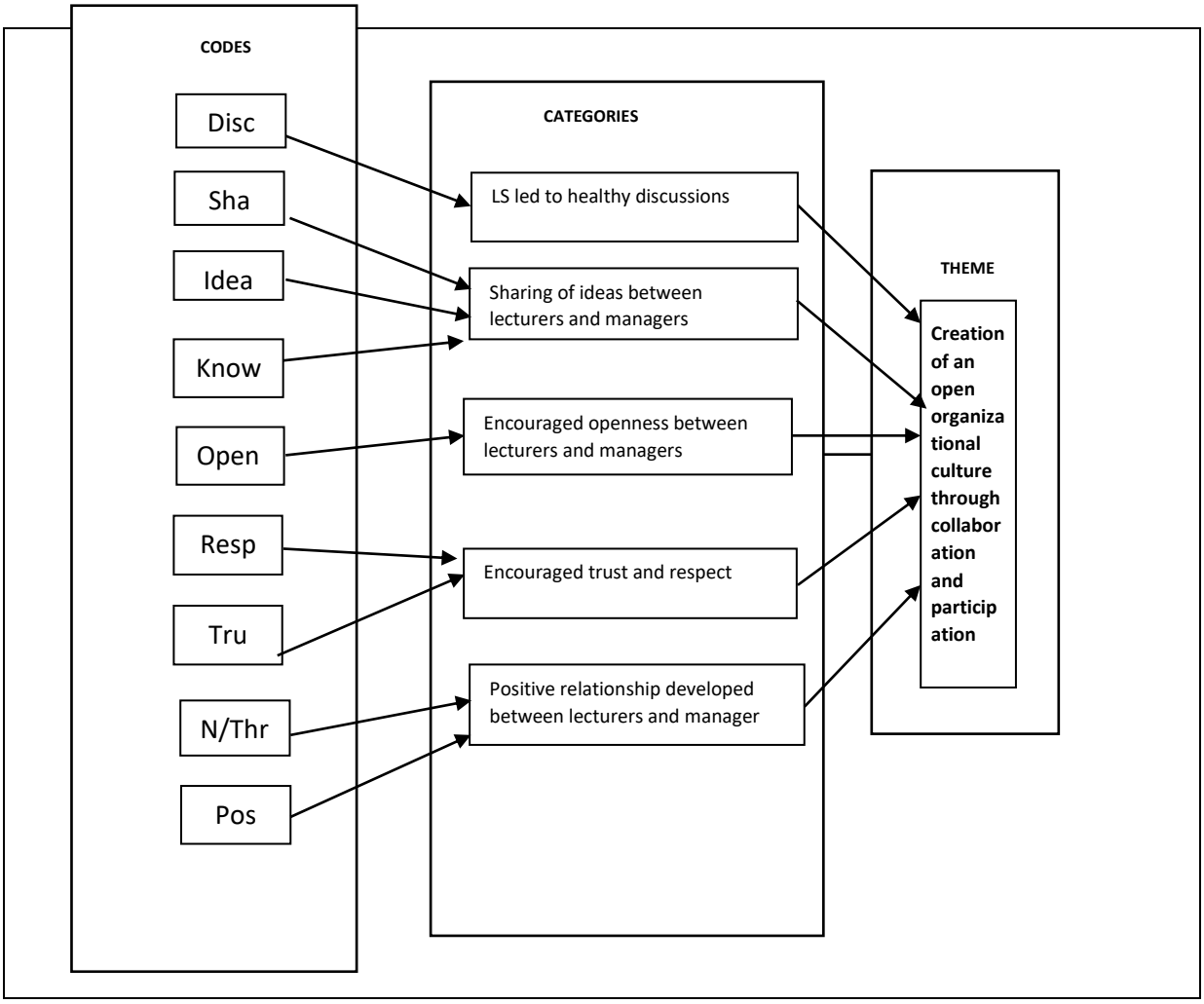
dimen, words, lang, form, unit, quest, real	Unit Dimensions Hypotenuse	space, shape and orientation • Experiences and improvements gained by lecturers	the content knowledge of space, shape and orientation.
CHAL, SHA, CURR, TRU, RESP, IDEA, POS, CONF, DISC, TEAM, OPE, COLL, PART, SUPP, GUI, LEVEL, FREE, EMP, MOT, OBSE, DEBR, TI, REFL, ISOL, MANG, T/T, BI, KNOW, BEN, T+L, AR, CHANGE, PSOL, VAL, CAMER, DELE, NJUDG, NAPPR, PROF, FBACK, ENGA, NT, INPU, B-U, PD, ST-SC, SKILLS, TRAIN, MISCON, GOAL, **RESOU** CL-PURP, TM, PRO/A,	Isolation Reflection Observation Student-centeredness Student's response	• Removed culture of isolation • Observation • Reflection and debriefing • Student-centeredness and problem solving • Students' anticipated responses	LS provides lecturers and managers with reflection on instruction and instructional leadership.
	Sharing ideas Discussions Open Culture Openness Trust & Respect	• Healthy discussions • Sharing of ideas and knowledge • Encouraged openness between lecturers and managers • Trust and respect • Open culture and positive relationships due to non-threatening approach.	Creation of an open organisational culture through collaboration and participation in LS leads to organisational effectiveness.
	Confidence Empowerment	• Lecturer confidence and motivation increased • Lecturers empowered to make decisions freely	Personal and professional improvement and empowerment of lecturers.
	Collaboration	• Improvement of participative and	Managers' role, contributions and

COORD, COMM, VIEW, NPUN, TVET, POWER, FLEX, GAPS, SUBJ, VIBE, ENTH, DRI, STRUCT, EXP, IMP, CRIT, PEER, DEV, ORG, OPIN, CONS, CRTH, STR, LEARN, AUTH, INSL, DICT, LCURVE, ANA,W+S, IMAGE, *RES*,	Participation Curriculum Management Guide and support	collaborative culture • Manager contributes as a guide and support • LS leads to improved curriculum management	participation in the use of LS at TVET colleges
	Time constraints *Attitude* Management skills **Resources**	• Time and time constraints • Attitude and resistance from participants • Managers' skills and knowledge • Lack of resources • Solutions to challenges	Challenges lecturers and managers encountered in conducting LS at TVET colleges.
	TVET Benefit Champions	• Participants as champions • The benefits of LS for the TVET sector	The future of LS in the TVET sector using the model of the LS participative management.
		• Need of manager to be involved in LS • A bottom-up approach when manager is part of the LS process	The need for the participation and involvement of management in LS.

5.2.1 From codes to categories to themes: An example

As explained above, after codes had been identified the researcher looked for categories by identifying patterns and then abstracting them into themes. The following is an example of a schematic process to depict the process as an illustration followed in this study.

Figure 5.1: From codes to categories to themes – A reduction example



5.3 RESULTS OF THE PILOT STUDY

A small-scale pilot study was done before the main study was conducted which consisted of two participants, both lecturers in ML at a different campus to where the main study was conducted. The purpose of the pilot study was to determine and ascertain the practicality and appropriateness firstly of the method of research, and secondly, the instrument and the time factor. According to Ismail, Kinchin and Edwards (2018), a pilot study helps researchers to test in reality how likely the research process

is to work, in order to help them decide how best to conduct the main research study. It was also conducted to ascertain how LS could be implemented in the TVET college and campus timetable structure in view of the limited time at lecturers' as well as managers' disposal and whether improvements could be made to organising time in the main study.

The pilot study was conducted over roughly two months with the Level 3 Hospitality students which commenced with a presentation on LS followed by three daily meetings of roughly an hour in a week which covered the research theme, and two meetings on planning of the research lesson. This was followed by two weekly meetings with the participants on planning of the research lesson. The research lesson was finalised the week thereafter. After the research lesson had been presented a debriefing was held, and two more meetings were held to review and eventually improve the lesson in the second cycle. Hence, one complete LS cycle and a second partially completed cycle were delivered with only the revised lesson in the second cycle not being delivered owing to time constraints.

A permission letter was also drafted and given to the lecturers and the students to sign as an initial attempt to gauge what the reaction would be and what questions would be asked from both lecturers and students. It was also used to gauge their willingness after explaining it to them in order to change the researcher's approach, if necessary. Fortunately, no major issues emerged and after the students had first been addressed by the researcher to inform them what he proposes with his research, students seemed enthusiastic and 17 students signed the permission letter. The two participants also willingly signed the permission letter. Hence, no changes were necessary to be made to the permission letters for the main study except to remove the word 'pilot' from the heading.

The interviews with the two participants were held on two consecutive days, digitally recorded and then transcribed verbatim. The purpose of those interviews was firstly to test the language used in every interview question in terms of understanding and substance, and secondly, to collect qualitative data and to see whether answers were sufficient to address the research questions.

This resulted in improvements in the following:

1. **Interview schedule:** In the interview schedule for the pilot study 11 questions were drafted, but in the interview questions in the main study the semi-structured interview extended to 15 questions (see appendix R). Since the response that the researcher was looking for did not emerge the way he intended in terms of management, he changed the schedule of questions and divided it into (a) general questions to do with lecturers' experience and impressions of LS, (b) questions around the research questions focusing on management, and (c) the future of LS at TVET colleges and the TVET sector in the model of including the manager in the process.

   The language of the questions also changed to make it more specific as the researcher realised that some questions were too loaded. For example, one of the questions in the pilot study was, *'What was your experience like having the manager as a member of the lesson study team? Was it a benefit towards working collaboratively?'* It was rephrased as, *'To what extent did the involvement of the researcher (manager/ education specialist) as a participant observer and collaborating in the lesson study process in every part of the lesson study process impact on the improvement in your instruction and lesson plans?'* in the main study.

Furthermore, the following aspects were added to the interview schedule questions in the main study which were not adequately dealt with in the pilot interview questions:

- General impressions of LS,
- Lecturer's focus on students,
- Improvement of positive environment and support with manager's involvement,
- Improvement in collegiality,
- Encouragement of sharing of ideas,

- Improvement in confidence and motivation,
- LS brought about respect and trust with manager present,
- The empowerment lecturers,
- The impact of LS on curriculum and curriculum management, and
- Future of LS at TVET colleges and the TVET sector with the model of manager included.

2. **Developing the research lesson:** A ready-made lesson plan from the Internet was adjusted and used. The reason was to get the LS off the ground as quickly as possible and to see how it could be implemented. In the main study a completely new lesson plan was developed from scratch so that all aspects of how to launch a LS session from start to finish through all the stages could be experienced by the manager (researcher) and lecturers. Furthermore, the objective was to observe how aspects of collaboration and participation of lecturers with the manager were experienced and to experience them over a longer period. It was also important to observe how lecturers engage and interact with one another and with the manager through the process of LS. This was achieved in the main study as the findings show.
3. **Participants' journals:** Since the pilot study was a small-scale study, the researcher did not request the participants during the pilot study to record their experiences and impressions in a participant's journal. It occurred to the researcher that this was a big short-coming and the researcher ensured that it was included in the main study as it highlighted some important points from the participants and a significant instrument to triangulate the findings.
4. **Students' interviews:** Owing to time constraints, no student interviews were conducted; the students' interviews were conducted after each cycle in the main study which was a powerful way of triangulating results with the participants' interview findings.

5. Some findings from the pilot study

The debate whether findings from a pilot study may be included in the main study is ongoing, but Ismail, Kinchin & Edwards (2018: 6) mention that in qualitative studies, since there are no drastic changes in the methods of the main study, researchers may use all or some of the data from the pilot study in the main study. To be on the safe side, the researcher in this study refrained from reporting the findings in the main study and merely included some here in the pilot study section instead. Hence, some findings from the pilot study worth noting and mentioning were:

When the following questions were asked of the participants:

R: How have you improved your instructional strategies in your lessons as a result of your participation in lesson study? Describe the improvement and the specific element of the process which facilitated your improvement.

The two lecturers, PPL1 and PPL2 responded in the following way. One lecturer responded on the observation process in LS and the other on the cards which were given to students on which the scaffolded questions were written.

PPL1: Without me knowing I have been taught through observing, uhm, what it means to teach a remedial student, what it means to teach a fast student so I will amend my lesson to the observation.

PPL2: The issue of task cards assisted in observing the paired students and assisted in the issue of observing and we were in a position to check the individual performance of students. I could actually see that some students were doing it faster than the other students as well due to the fact that we have cut up the questions.

When comparing the usual PD method with LS, the researcher asked the following question:

R: In which way did you experience the lesson study process as an effective form of professional development? If so, how and in which ways?

The following was one of the responses.

PPL2: They (PD) lack follow-up activities unlike the LS, where we had to reflect immediately and time for reflection when we debrief.

In connection to the positive relationship between him and the lecturers and also between him and the manager, the following question was posed:

R: What in your opinion was the strongest and most powerful part of the LS process? Which made the most impact for you?

The lecturers answered in the following way:

PPL2: It (involvement of manager in LS) also created a mutual positive relationship between me and my manager and the other participants. We realised that with this LS we became closer.

He explained further that open communication was paramount:

PPL2: The whole idea was to come up with a group thing and not an individual thing. Our plus in the whole process was effective communication. Criticism was taken positively in order to produce a group lesson study and not an individual thing. Communication was very positive and if communication is positive a member does not feel neglected and the opinions coming from other members is not looked down upon. I did not see that anyone looking down upon and also from the manager side. That made our LS very successful and effective and I believe for other LS to go on like that if the manager is involved.

PPL1: Most definitely especially the council of many brings confidence because there is the council of many and the council of management and their presence and assistance. With lesson study and what we are expecting students to do we will be more accurate.

He continued by saying,

PPL1: Having more than one lecturer in the room at delivery time and one being a manager also impacted on the way I saw my own teaching and made me reflect on my own teaching which motivated me to improve myself. The manager being there from the start talking through all the content, targets and outcomes made my experience empowering.

The following lecturer had a very interesting point in that he says that collaboration *is* LS and we should not even ask how collaboration can assist a college and subjects. He also mentions that LS through collaboration and participation creates and encourages a learning culture in which everyone improves and transforms through change. He mentioned that,

PPL1: The question that needs to be asked is 'how was the collaboration in the LS process?' and because of the process we almost don't need that question. The collaboration in the LS process comes naturally. If we take part in it together (participate) we will not fear change because we are realising that this which we are doing is increasingly improving, but what needs to happen is that we change according to how it improves. Because the next time I will do it differently and it cultivates in me to stay with it. And it remains formative the whole time, you are being formative in your approach, and everybody is being formative in their approach.

When the researcher asked the lecturers,

R: How can LS feed into the curriculum?

The following lecturer mentioned that he found that the collaborative and participative approach of LS led to healthy and positive discussions and debates on the ML curriculum between participants and the manager. It also forces focus on the curriculum and its appropriateness and encourages a bottom-up approach. He pointed out that,

PPL1: We were even talking about curriculum and whether the curriculum and the syllabus are appropriate for the different levels for the NCV curriculum and we narrowed it down. So, LS also forces you to focus deeply also on the curriculum and how the process of LS can give input to amendments to the

curriculum maybe at ML FG (Focus Groups) so that it can also not always be only top-down, but also bottom-up. In multiple ways we talk about how curriculum is outdated. We have done this so many times and it is not working and here in LS we see what is working and not working. Is the issue not maybe curriculum?

The above question and the response of this participant brought the researcher to the realisation that a stronger question needs to be included in the interview schedule in the main study.

The following findings were in relation to the following question:

R: To what extent did you feel free to make comments and give inputs into the LS process?

The following lecturer felt empowered by the fact that everyone agreed on every phase of the LS process and the participation of each one was necessary. He also mentioned that the process was not policed and it won't and managers should not be taking a policing stance. He points out that,

PPL1: No, I did not feel threatened in any way, I actually felt empowered because what has been done before in the LS stages was signed off so to say by all the participants. We have done this together and that made us empowered, we felt empowered and everyone agreed and it was a collective and collaborative process and in participation with one another. We were not policed. LS is not going to work if management is going to police the process. The power of LS is that it made us empowered. It really builds confidence.

The following lecturer referred to how having the manager as part of the LS process enhanced his teaching and motivated and empowered him. He added that,

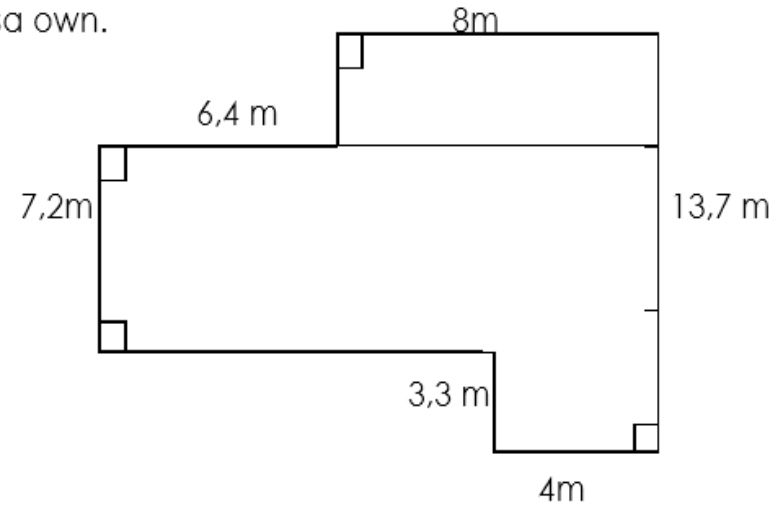
PPL1: It was not just a checking up. That was powerful. Builds confidence and a new experience. There was no fear and myself and the other participants freely said what we wanted to say and there was no fear.

The pilot study, although incomplete and small-scale and of a short duration, was a valuable lesson and gave a very thorough overview of how shortcomings found in the pilot study could be improved in the main study. Furthermore, the findings from the pilot study highlighted many similarities in the views of participants in the main study which showed once more that the voices of participants were strong.

The problem (activity) given to students in the pilot study and around which the research lessons were designed collaboratively. This activity was found on the Internet as mentioned before.

Figure 5.2: Initial diagram for pilot study

1. The picture below shows the dimension of a piece of land that Musa own.



Calculate how much fencing Musa will need to erect a fence around the land. (5)

Source: Grade 11 Mathematics Literacy Lesson Plans, Gauteng Department of Education (CAPS version).

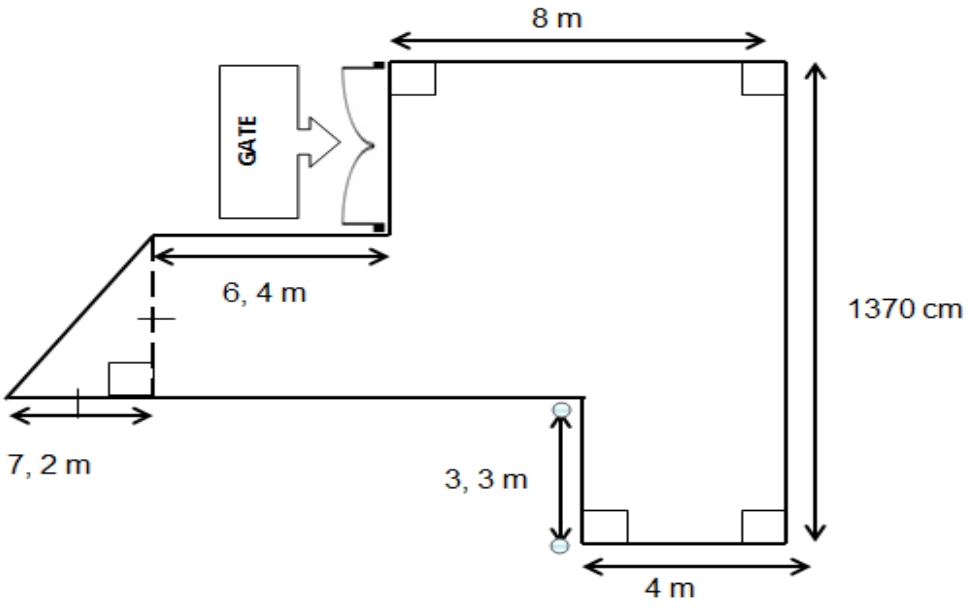
The following changes were suggested in the lesson study meetings and hence the activity was amended accordingly.

- Change at least one dimension to cm so that students can at least convert a unit.

- Include a gate so that the length of the fence can become more challenging. It was later decided to let students first calculate the length of the gate.
- It was also decided to remove the line inside the diagram in order to see how students themselves subdivide the given area to calculate the area.
- At least include a calculation for students to use Pythagoras.
- Make sides of triangle equal and include the equal symbols.
- Indicate the gate on the diagram.

This resulted in the following final worksheet which was used for the first research lesson in the pilot study.

Figure 5.3: The amended diagram for the pilot study



The following questions were asked:

a) Calculate the length of the gate indicated on the diagram.

b) Calculate how much fencing Musa will need to erect a fence around the land.

c) Calculate the area of Musa's land.

In the research lesson which was delivered in this pilot study we did not reach question (c) above owing to time constraints in the period. This was also taken into account when planning was done for the research lessons for the main study.

From the debriefing sessions after the first research lesson, the two participant lecturers mentioned the following from observing the case students appointed to them.

> *PPL1: As far as the gate was concerned students did not see it as a gate, nor did they see it as a symbol for a gate; hence they added it to the length of the fence required. Furthermore, most students did not pick up the signs showing equal sides on the diagram for the triangle. Only one student saw the equal sign of the students I observed.*

The issue with regard to the gate was also mentioned by the other lecturer and he mentioned that,

> *PPL2: On the diagram students confused the gate as part of the land and added it to the length of the fence.*

On the issue of not linking the fence to calculating the perimeter, it was also noted by the following lecturer when he mentioned that,

> *PPL2: Students did not know they had to calculate the perimeter when asked to calculate the length of the fence.*
>
> *PPL2: One student also mentioned he is completely blank.*
>
> *PPL1: I also observed that there is a misconception with regard to around the figure for calculating the length of the fence and outside. So, there is also a language problem in how they understand the terminology.*

In the researcher's observation recorded in his journal he recorded the following:

R: noted that students worked individually even when this was an activity for students to work in pairs to see how they discuss and what they discuss.

R: One student converted the cm to m correctly, while two did not and this led to an incorrect answer.

R: Some students added the gate to the length of the fence instead of subtracting it.

R: Some students calculated area instead of the perimeter and some used the perimeter formula P = 2l +2b.

From the observation sheets the following was recorded by the participant lecturers on the case students they observed in support of what was mentioned in the debriefing as well as the researcher's documentation in what he recorded. Furthermore, additional observations from the participant lecturers were also recorded.

PPL2: One student tried to use the ruler to measure the length of the gate and other lengths.

PPL2: Some students struggled to calculate the hypotenuse as well as finding the missing dimensions.

PPL2: Some students struggled to convert the unit of 1370 cm to m. Others did not notice that there was a dimension of cm.

PPL2: Some students added the dimension of the gate to the length of the fence.

The following participant lecturer recorded the following on his observation sheet:

PPL1: Students did not subtract the length of the gate from the length of the fence, while others were confused with the symbol used for the gate.

PPL1: Some students did not use the correct units in their final answers.

The researcher recorded the following in his journal on the students he observed at random:

R: Some students drew a diagonal across the top and some students struggled to find the missing dimensions.

R: Some students obtained 10,4 m for the gate by only subtracting 13,70 - 3,3 and some students calculated area by dividing up the land in subdivisions thinking they must calculate the area. Confusion with area and perimeter.

R: Some students used the formula for the perimeter of a rectangle even though it was an irregular shape, while others added the dimensions of the gate. Students who were on the right track to calculate the length of the fence added the length of the gate.

R: Some students converted incorrectly, they divided 1370 ÷ 10 instead of 100.

The following lessons were kept in mind when the activity was designed for the research lessons of the main study:

- Not to include too many dimensions.
- Not to convert dimensions.
- Do not use any equal lines.

5.4 THE RESULTS OF THE MAIN STUDY

Each of the themes identified above will now be presented with subthemes and the results from the interview questions.

Theme 1: Opportunity to improve lecturers' experience in the content knowledge of space, shape and orientation

In this theme, the following items served as sources of data:

- the debriefing meeting notes from the two sessions, one after the first research lesson and the other after the revised research lesson in the second LS cycle,
- lecturer's observation sheets,

- researcher's observation,
- student interviews and
- students' answer scripts.

LS provides lecturers and managers sufficient time to engage, interact and concentrate on the content of certain topics in subjects and targets with their attention on specific sections of the topics within a subject. This happens by way of many interactions between lecturers throughout the LS procedure, from setting the goal to presenting the lessons and especially during the design of the research lessons. This was also the case in this research study where the goal was clear and the interactions, collaborations and engagements were very fruitful and beneficial to highlight lecturers' experiences. It also provided an opportunity for lecturers to learn and improve through these experiences. Hence, the two sub-themes identified in this theme were (1) challenges for students and experiences for lecturers highlighted in space, shape and orientation through the LS process and, (2) experiences and improvements gained by lecturers through engaging with the content of space, shape and orientation.

Sub-theme 1: LS highlighted challenges in teaching and learning regarding space, shape and orientation

The following problem was presented to students in the two research lessons which became the activity to highlight the experience of lecturers in the content on space, shape and orientation. The questions which accompanied the activity were given piecemeal on strips of paper as the research lessons indicate (see appendix K).

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	The principal of a school asked the gardener to design a play area for the pre-schoolers. Basic shapes had to be used. The gardener designed a circular flower bed within a rectangular lawn. A triangular sandpit was built on the one side of the lawn. Refer to the picture below and answer the questions that follow.			

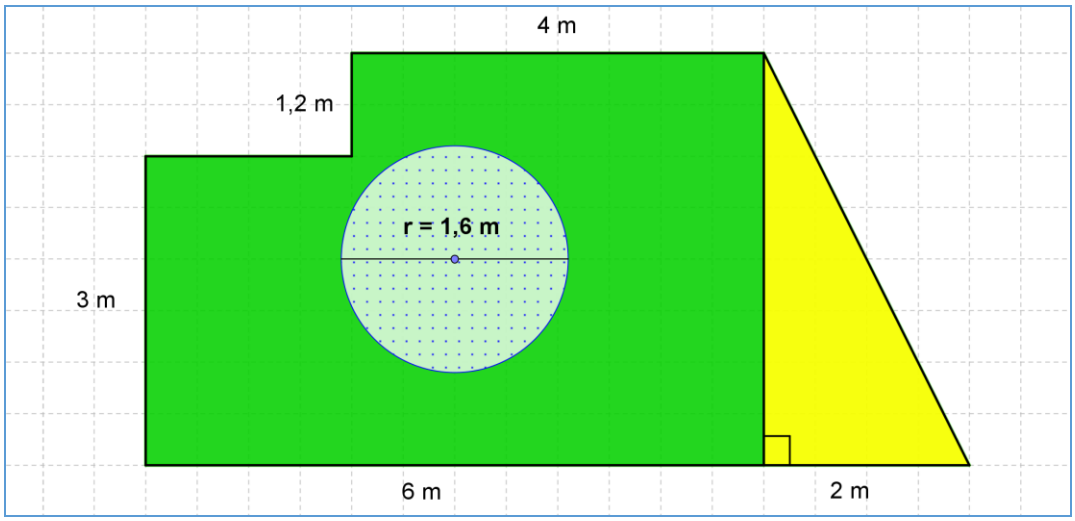


Figure 5.4: The problem in the first research lesson

The following questions were given on strips of paper in a piecemeal way:

	(a)	Calculate the length of fencing required to enclose the play area.		

	(b)	Owing to the water restrictions in the area, the lawn must be replaced with artificial grass. Calculate how many square metres of artificial grass the principal must purchase.		

	(c)	The principal decides to put a plastic cover over the sandpit (the triangular part) when not in use. Calculate the size of the plastic cover required.		

	The principal of a school asked the gardener to design a play area for the pre-schoolers. Basic shapes had to be used. The gardener designed a circular flower bed within a rectangular lawn. A triangular sandpit was built on the one side of the lawn. Refer to the picture below and answer the questions that follow.		

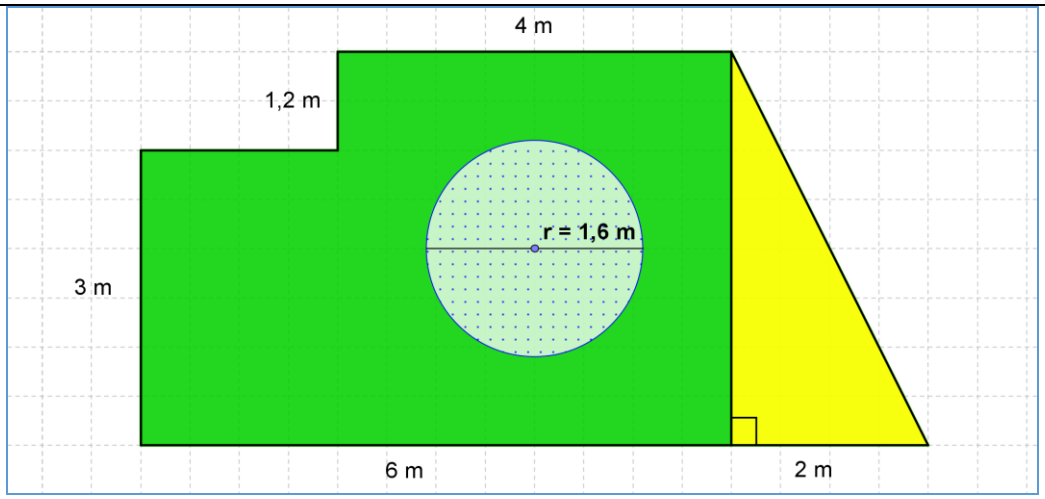


Figure 5.5: The problem in the second research lesson

The following questions were given on strips of paper in a piecemeal way:

	(a)	Calculate the length of fencing required to enclose the play area.		

	(b)	Owing to the water restrictions in the area, the lawn must be replaced with artificial grass. Calculate how many square metres of artificial grass the principal must purchase.		

	(c)	The principal decides to put a plastic cover over the sandpit (the triangular part) when not in use. Calculate the size of the plastic cover required.		

Students' interviews after delivery of first research lesson

In their interviews students made their own confessions as far as their misconceptions were concerned. Many of the students' confessions were also found in lecturers' observations as documented on their observation sheets during the research lessons as a way of supporting their statements. Similarly, the statements were also highlighted in the debriefing sessions after each research lesson.

When the researcher asked the students the following question, *"What were the errors in your thinking?"* students answered in various ways.

One striking misconception was that some students thought that there is only one formula and they tried using this one formula even if the shape is irregular as in the problem presented in this research study.

> *I always thought that Mathematics just had one formula like in anything that you do, like one formula for area even for an irregular shape, I always thought that.*

Another misconception which was very common and glaring which was also confirmed in this study was the fact that students confused calculating perimeter with area. This is highlighted by the following student.

> *Sir, my error in thinking, sir, is confusing calculating perimeter for certain shape with area for certain shape because it is more or less the same, so instead of using a plus I used to put a multiplication sign, so confusing signs, so confusing multiplication and plus when calculating perimeter and area.*

Another student also said that he confused perimeter with area.

> *I confused perimeter with area.*

From both the student interviews four students said that they confused perimeter with area.

Students also confused the use of units because when they wrote down the final answer, they would write down 4,2 m^2 instead of 4,2 m, when calculating perimeter, which clearly shows that there is a lot of work to be done with units.

> *And sir let's say you are calculating perimeter, and your final answer is say, 4,2 m^2, so confusing units as well.*

Findings mentioned by participant lecturers in the debriefing sessions after the research lessons.

Observations of case students by participant lecturers also revealed misconceptions in the debriefing sessions. In the first debriefing session after the first research lesson, the following two lecturers observed the following about the case students and mentioned that,

> *PL3: Since the keyword 'perimeter' was not there the students that I observed did not know they had to calculate the perimeter when we asked about the length of the fence.*
>
> *PL1: Students got confused with the word 'length' and did not link it to the word perimeter and hence did not know they had to calculate the perimeter.*

She goes on to say that finding missing values (dimensions) was also a problem,

> *PL1: Some students closed the big rectangle but did not know how to calculate the missing values.*

From PL1's observation sheet she recorded the above for the weak students. Also, that some close the entire shape but do not know how to progress from there. For the above average students, the rectangle was also closed to calculate the missing values, but they first calculated the slant (hypotenuse) by means of Pythagoras.

The issue regarding the confusion with the perimeter and area was further highlighted by the following participant lecturer in his observation of case students. He mentioned that,

PL4: The students were also confused with the inside line (the perpendicular line) and these students added this to the perimeter. These same students knew they had to calculate the length of the slant, but struggled using Pythagoras and hence got it incorrect. I clearly picked up that they also did not know what perimeter meant.

Lecturer PL2 also recorded the issue of perimeter on his observation sheet.

PL2: Student did not know he has to calculate perimeter.

Further to the debriefing session, the following lecturer also recorded the following in his observation sheet for the case students he was observing:

PL4: Student identified Pythagoras, but did not identify perimeter. For calculating the area of the play area, the weaker student could not identify which play area and which shape and formula to apply.

In the researcher's walk around in class he also observed that some students were adding the inside line and some students were confused with area and perimeter. The researcher mentioned this in the debriefing session as follows,

R: There were students who closed the diagram (by joining a line on top as if to use Pythagoras). Furthermore, more than one student added the inside line (the perpendicular line of length 4,2 m).

PL1: I also noticed that one student closed the area by joining a line on top.

The researcher continued by saying that:

R: Students did not know whether to add or multiply, which clearly indicates that there is a confusion between area and perimeter.

Related to this, another participant lecturer also observed that:

PL1: The students just manipulated values that were there which were unconnected and did not make sense. For example, they multiplied 6 x 3 to get 18 just because the values were there and they tried to manipulate just to obtain an answer.

The researcher also noticed that some students thought that the line at the bottom is equal to the line on top. He recorded the following in his observation:

> *R: Some students thought that the line at the bottom of the diagram (6 + 2) is equal to the line on top. Hence, they obtained an incorrect perimeter.*

However, the researcher did also mention that he observed that two students did it correctly and their answers were spot on.

> *R: I observed that two students did it correctly and there could be a few more.*

As far as the last question was concerned regarding the area, the following participant lecturers also added the following:

> *PL2: Students could not link shapes with formulas, even though a sheet with formulas was provided with the accompanied shape.*

> *PL1: Students also did not know which area to use. First, they used only the small area then they went over to the big area, so there was clearly a confusion there.*

The presenter of the revised research lesson in the second cycle mentioned that:

> *PL2: I think this time we were better prepared and students worked well. Students were very perceptive towards the lesson. The group work was very good and they grappled with the problem. Some came up with a few wrong answers and noticed that in the A group two had it correct for the first question and I was actually surprised by that.*

He went on to mention that,

> *PL2: For the second question, very few had it correct in the second group. What was really surprising to pick up for me was the fact that some students calculated the perimeter of the frame in which this diagram was in (laughs from all).*

From the researcher's observation the following was recorded in the revised research lesson in the second cycle regarding the first question of calculating the length of the fence:

R: Some students wanted to add the circumference of the circle also to the length of the fence.

R: Closed the area as in previous cases.

R: Some students did not calculate the slant (hypotenuse), but added the perpendicular line as part of the perimeter.

As far as the second question on area is concerned, the researcher also observed the following while walking about in class during the presentation of the revised research lesson. The researcher observed that,

R: Some students did not subtract the area of the circle even though they have calculated the area of the circle when calculating the area of the play area. Some students also calculated the perimeter instead of the area as they were adding the given lengths.

Students struggled in the use of formulae as the researcher observed with some students. The researcher observed that when students applied the formula for the area of the circle they forgot or did not square the radius.

R: Some students forgot to square the radius (r) in the area of the circle. Another student divided the radius by 2.

In the question where students were asked to calculate the area of the sandpit (the size of the cover to cover the sandpit) the researcher documented the following:

R: The student added the dimensions of the triangle (lengths of the triangle). They could not 'see' that they had to calculate the area of the triangle.

From the observations which were documented by the participant lecturers on their observation sheets, the following can be noted in support of what was already mentioned in the debriefing sessions.

PL3: Formulas were correctly identified, but missing values, that is, finding the lengths of the missing values (the sides) were problematic. The yellow triangle section in determining the perimeter was excluded so they did not calculate the

slant (hypotenuse). For the second question the perimeter formula of the rectangle was used when calculating the area of the rectangle. Furthermore, the length of the radius of the circle was subtracted.

The following was also documented on the observation sheet with regard to calculating the area of the sandpit.

PL3: In some cases, two areas were calculated for the triangle, one with perpendicular height and one with the slanted 'height'

For the first question the following participant lecturers recorded the following on their observation sheets on the case students they observed.

PL4: Students were not sure what to do and they could not answer the question. One student read the question repeatedly. They found it hard to interpret the question. They eventually realised length refers to perimeter, but did not use Pythagoras.

PL1: Students immediately found the length of 8 m (6 + 2) and 4,2 m (3 + 1,2 the perpendicular height). There was good discussion with members. Students started calculating area. One student in the group recognised that perimeter should be calculated and not area and took a leading role in the discussion. Sub-divided the dark green area into smaller rectangles and did not calculate hypotenuse.

For the second question the above participant lecturers recorded the following on their observation sheets on the case students they observed:

PL4: Students did not know they had to calculate the area and they found sub-dividing the shape into the decomposed areas. They realised that the area of the circle has to be subtracted, but did not obtain the answer. Group communication was lacking, but students tried their best to reach an answer.

PL1: Students could immediately identify that they had to calculate the area. Calculated the area of the circle but stopped here and did not continue. They realised that two areas had to be calculated (rectangle and circle) and the circle

had to be subtracted. Closed the entire rectangle and calculated 4,2 m x 6 m, but forgot to calculate the 'little rectangle' on top left and subtract this from the area of the rectangle obtained. Students did not continue from here and thought they were done. Even though the answer was incorrect they were very confident that the answer was correct.

For the third question on calculating the area of the sandpit these lecturers documented the following on their observation sheets:

PL4: All the students in my case group struggled to obtain the answer. They identified the correct height (perpendicular line), but some did not know they had to calculate an area and did not link the word 'size of the plastic cover' with area. The most interesting was that one student measured the distance of the height with a ruler.

PL1: Students thought they had to calculate perimeter. They added 4,2 + 2 + 4,65 and did not understand the word 'cover'. They then consulted the lecturer and quickly redid it to find the correct answer. One student first calculated 4,6 x 2.

On the above issues the researcher recorded the following in his observation:

R: Some students closed the area and calculated the perimeter of the entire rectangle. They also forgot to calculate the slant (hypotenuse). Some students worked on the circle and were calculating the area instead of the perimeter. Some students were calculating the perimeter of the frame in which this diagram was drawn. Some students added the perpendicular line inside the diagram to their answers.

R: Some students followed the correct procedure, but forgot to square r in the area of the circle. Some students did not subtract the area of the circle, while others divided the radius of the circle by 2.

R: Students added the dimensions of the triangle. Some did not use the correct formula even though a formula sheet was provided. Many students obtained the correct answer.

There was the misconception that whenever there is a slant in a diagram, students think that the length of the slant can be calculated in the normal by way of looking for the missing dimension in the diagram. They do not realise to apply the Pythagoras theorem, even when a 90 degree (or perpendicular line) is shown on the diagram. Those who do realise to use the theorem also applied it incorrectly. When adding the square, they squared the combined sum instead of the individual sums. For example,

$$4{,}2^2 + 2^2$$

$$= (4{,}2 + 2)^2$$

$$= (6{,}2)^2$$

The following student expressed it as follows in the student interview:

Forgot to use Pythagoras and when I did realise to use Pythagoras, I applied it incorrectly.

A further confirmation that a slant in a diagram caused an error in thinking was when the question of perimeter was asked, the case students that the following participant lecturer was asked to observe mentioned in the debriefing session that,

PL3: The case students in my group the discussions between students were good. They only calculated the perimeter of the rectangle, but did not calculate the length of the slant (hypotenuse) thinking that it is the final answer for the perimeter.

He further mentioned the that,

PL3: When the question to calculate the square metres was asked, they could not link it to area and calculated the perimeter instead by using the formula for the perimeter of a rectangle. And when they did calculate the perimeter, they

subtracted the radius of the circle instead of subtracting the area of the circle. I learned a lot.

Strangely enough the following participant lecturer found that in his observation of his case students they also subtracted the radius of the circle and he mentioned that,

PL4: When it came to the first question, they were very uncertain first of what to do and then one student correctly identified that the word length referred to perimeter and that sort of sparked them, but at the end they also ended up also to subtract the radius of the circle as is mentioned. However, the students participated well with one another.

On this same issue of calculating the square metres, the following participant found a similar issue in his observation with his case students when he mentioned in the debriefing that,

PL4: They struggled to link this question (c) with area.

A further error in thinking was a striking one and one that would explain why students sometimes do not continue with the calculations. The following student highlighted this fact when calculating the perimeter, by stating that *'I thought that I had to calculate only the length of the sides'* which clearly shows that he does not know that perimeter is the distance around the outside of the figure.

From the second debriefing meeting, the above error in thinking was also highlighted when students had to calculate the area. As one of the participant lecturers mentioned from her observation:

PL1: They only calculated the area of the circle and thought they were done.

Words can indicate misconceptions with students when they understand words differently to what lecturers understand. Over and above the confusion between perimeter and area, students could not link the word 'fencing' with perimeter when they were asked to calculate how much fencing is needed. In this respect the same participant lecturer from her observation mentioned the following in the debriefing when she said that:

PL1: This one student also had a problem with the fencing question and he did not understand that fencing had to do with the perimeter and instead worked out the area.

When it came to calculating the length of the fence, the following participant lecturer noticed that even though the diagram was not drawn to scale some student went to measure the height of the triangle with a ruler and used that in his calculation. He mentioned that:

PL4: One student took a ruler to measure the height of the triangle.

To which another lecturer added,

PL2: So that should be an improvement in our next revised lesson that we should mention in the question that 'the diagram is not drawn to scale'.

On the same issue of words used in questions and the terminology used in Mathematics the same participant lecturer mentioned in the debriefing from her observation that,

PL1: One must be careful which words we use when formulating questions, since the question of how much 'cover' is used (to work out the area), the one student wanted to cover the triangle with a big rectangle, which can also work because we did not say it has to exactly or perfectly fit, because you can put something over the triangle (even if it is much larger) it is still 'cover' and the answer is not incorrect.

The following participant lecturer added the following to this:

PL4: It is like when you cover a bed with a blanket it still hangs over and it is not an exact fit for the bed. In this case we cannot really say the answer is incorrect.

The following participant lecturer made a very important point in the debriefing session with regard to collaboration in this revised research lesson in this second cycle.

PL1: Nice to have colleagues in the class because each observer picked up different things and it is shared (in this debriefing). One lecturer will not be able to pick up so many things by herself/ himself.

On the issue of language, the next student mentioned the following in the student interview:

> *I understand that Mathematics is taught written in English, but maybe sir invite a person who is more diverse in terms of languages maybe who can explain things to other people let's say I am an Afrikaans speaker, there is a question that I don't understand he can explain it to me*

From the student's answer sheets analysed by the researcher the following was found:

> *R: Some students correctly drew the triangle by finding the perpendicular height correctly and then continuing calculating the hypotenuse correctly (4,65 m), but stopped here and did not continue to find the length of the fence (perimeter). This same student had the correct answers for (b) and (c).*

Student's answer sheets in support of the documented notes above and debriefing sessions.

Figure 5.6: An explanation of students' answers

The following student finds the hypotenuse correctly (4,65 m), but then commences with a multiplication for area: *A = 8 x 4,2 = 33,6 m^2 and he incorrectly adds the perpendicular line inside the diagram (4,2 m) to calculate the perimeter as follows:* *P = 3 + 2 +1, 2 + 4 + 6 + 2 + 4, 2 = 22,4 m* *And then writes 27,05 m by adding 4,65 (slant) but then forgets to subtract the 4,2 he initially incorrectly added. This same student also got (b) and (c) correct.* *See students' work in appendix O.*
The following student finds the hypotenuse correctly (4,65 m), but then adds incorrect lengths for the perimeter: *8 + 4,2 + 8 + 4,2 = 24,4 m which clearly shows that h/she added 6 + 2 + 4,2 twice as if using the formula for the perimeter for a rectangle.* *For the second question (b) the student first divides the radius by 2 for calculating the area*

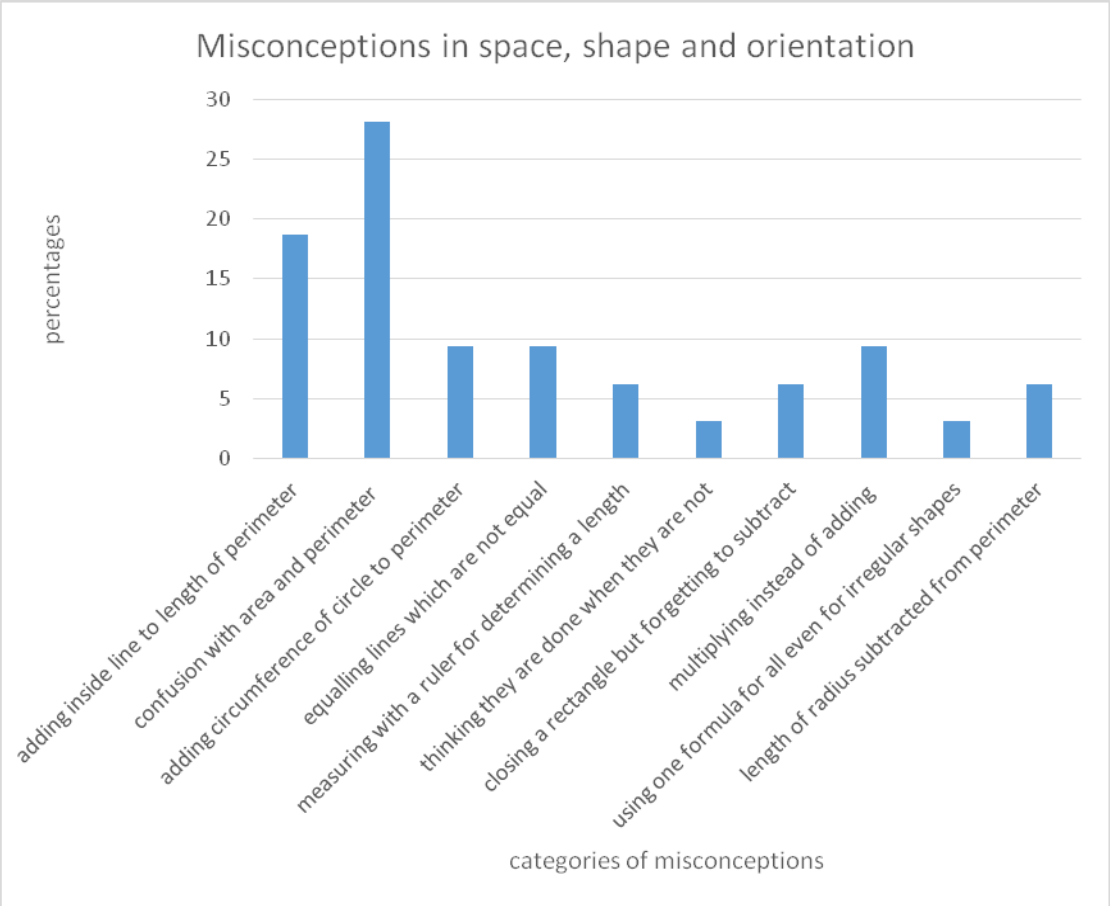
of the circle and then does it correctly and obtains the correct answer. See students' work in appendix O.
The following student thinks the perpendicular line of 4,2 and the slant are equal and adds it accordingly in the calculation for (a) as follows: *6 + 2 + 8,4 + 4 + 1,2 + 3 = 24,6 m which shows that this student also added the inside perpendicular line for the perimeter. Then this student instead of calculating the area of the green shade calculates the perimeter, and then subtracts the area of the circle (correctly calculated, but incorrect steps shown. Which clearly shows a few confusions and misconceptions. See students' work in appendix O.*
Many students when calculating the length of the fencing did not add the missing dimension of 2 m: *P = 4 + 1,2 + 3 + 6 + 2 + 4,6 = 20,8 m and for (b) when closing the rectangle forgot to subtract the little rectangle on top.*

From the above findings, which includes participant lecturers' observation sheets, debriefing sessions, students' answer scripts and students' interviews, experience gained by participant lecturers and the researcher may be categorised into three main groups:

- general misconceptions by students
- areas students struggle with
- students' lack of knowledge

From the findings, the group that stands out most were misconceptions. At least 10 different misconceptions could be identified in this particular study through the vehicle of LS. These misconceptions were mentioned/ documented 32 times. In terms of percentages, the following bar graph indicates the further division of misconceptions in terms of its different categories.

Figure 5.7: Misconceptions in space, shape and orientation



The graph above clearly shows that in this study the greatest misconception was confusing calculating perimeters with calculating areas, followed by students adding a line, which appears inside a shape, to the perimeter of the shape.

It was also found through this study that students lack knowledge when dealing with space, shape and orientation in the following areas:

- use of units (for example, confusing m and m^2 for perimeter)

- words, terminology and language
- matching the shape to incorrect formula
- incorrect use of formulae

The above categories on space, shape and orientation that students have a lack of knowledge was mentioned/documented 11 times and the following table indicates the percentages in which they were mentioned/documented.

Table 5.2: Students' lack of knowledge in space, shape and orientation

Student's lack of knowledge in space, shape and orientation in this LS study	
Categories of sections where students lack knowledge	**% number of times mentioned (frequency)**
Use of units.	18%
Words, terminology and language.	28%
Matching the shape to incorrect formula.	18%
Incorrect use of formulae.	36%

From the table above it is clear that when students used formulae in this study, they used them incorrectly, or substituted values incorrectly. Furthermore, it was also noticed in this study that words which are used to formulate questions have an influence on the way students calculate their answers and how it influences the terminology used.

Students also struggle with the following:

- Finding missing dimensions on an irregular shape

- Sub-dividing an irregular shape into its decomposed areas
- Struggling to calculate hypotenuse (Pythagoras)

The above categories on space, shape and orientation that students struggle with was mentioned/ documented 13 times and the following table indicates the percentages in which they were mentioned/ documented.

Table 5.3: Areas students struggled with in space, shape and orientation

Areas students struggled with in space, shape and orientation in this LS research	
Categories of sections students struggle with	**% number of times mentioned (frequency)**
Finding missing dimensions on an irregular shape.	31%
Struggling to calculate hypotenuse (Pythagoras).	54%
Sub-dividing an irregular shape into its decomposed areas.	15%

The above table indicates that students mostly struggle with the application of the Pythagoras theorem to find the hypotenuse as was shown in this study. This study also showed that, given an irregular shape, with some missing dimensions, students struggled to find those dimensions through calculations and hence did not continue with the question.

Sub-theme 2: Experiences and improvements gained by lecturers through engaging with the content through participating in LS

Interacting with the content and participating in the LS process, provided participant lecturers with a great deal of food for thought in reflecting on their own teaching and learning, as well as encouraging an improvement on how to implement their classes and design lesson plans to effectively deal with the areas that students found challenging.

The interviews conducted with the participant lecturers served as the source of data for this sub-theme.

When lecturers were asked how they delivered their lessons in space, shape and orientation prior to participating in LS and how they have improved after the LS:

> *R: How did you approach your lessons in space, shape and orientation before LS and how have you now improved?*

The following lecturer mentioned that he improved from the traditional way of teaching to the questioning and the student-centred approach he now learnt in the LS process. He mentioned that:

> *PL4: So basically, what I am saying, there is instead of the traditional way of teaching students all the time, it's also better to actually to question them on what they know and ask them how can they use that in this situation, for example, for the exercise that we gave them more like a problem-solving approach. If students are not able to answer then I provide more information to them to help them, but it is important that the information must be provided in stages instead of just providing them like spoon feeding them. I am introducing more group work in my lessons but I don't do it every day, not often because you can't do it every day.*

He continues to mention how he learnt from the LS process:

> *PL4: Because in the LS (while observing the case students) I sat with the students although I wasn't communicating, they did try to ask me questions and I didn't give them answers to answer them, I just questioned them on their questions like for example "do you really think you have to include the side of the shape" or " but how can you do that, how can you add that value if it is not part of*

the shape" for example, and then it made them think, so I got to see it from a student's perspective within a teaching environment which I don't normally get while I am in my own teaching environment and that student perspective uhm made me realise that sometimes the students are really trying their best.

This same lecturer is now following a totally different approach from the experience he gained from the shared collaboration in the LS process. He mentioned that:

PL4: I have taken questions from past examination papers and I would give it to them and I would tell them to solve it using their books as a guide, giving them less information like we did in our LS, for data handling as we are busy with it now. So, the formula was there. Like last year when I have done data handling, I used the same document and I did all the questions with them, but this time around I only did question 1 with them and I said "Right guys OK now you are going to do this on your own, you have got all the formulas and I am here to facilitate and you are going to do it on your own and they did question 2, 3 and there were a few students who did up until question 5, in one period.

The following lecturer was also encouraged by the questioning approach, but slightly in a different way and he uses it mostly when he introduces a new topic to students in space, shape and orientation.

PL3: They know that that is a circle, but now we unpack and we ask. This is the circle and how is the circumference, how does it differ to a perimeter? Is the perimeter and circumference different things? But what is the circumference? How does it differ from a perimeter and an area and so on? So that was now my approach.

Observing the case students would never have brought to light those hidden aspects which usually go unnoticed in the usual traditional lesson delivery. The LS approach highlighted this through the documentation on the observation sheets and mentioning it in the debriefing sessions that the correct use of language and words is very important. The awareness of this now plays a large part in how questions are formulated and this is also seen as an improvement.

PL3: OK and now if I develop a question like we don't say calculate the area, we say how much cover, you see we don't say those kinds of things. Or, I think that will help me now in the in the case of the classroom, just to emphasise when I'm teaching to emphasise. This is the area and to form a link. This is how much to cover. Okay, so that they know the terms by linking on the other mathematical terms that can be used. That is the first thing that I have learnt and now use. We also have learned teamwork.

The following lecturer also added his voice to this by saying that he is now aware of how he formulates questions. He first reminds us,

PL2: That one student where we asked cover the area, and what is a cover actually so you have to be … your wording must be precise. Remember that one guy measuring (with a ruler)? And we did not say it is actual size.

PL2: So, it taught me that when you set your paper, also when you set your questions, the wording must be correct.

A lecturer also mentioned that scaffolding the questions as was done in this study, and then using observation to identify and analyse misconceptions is also what he has improved on. He mentioned that:

PL3: We take one question, then we analyse the misconceptions for that particular question. So, that's what I was not doing before, but I learnt and managers can also learn from that.

The following lecturer further mentioned that LS taught him to focus more on real-life situations for students which he learnt from the LS process. He mentioned, for example, that,

PL2: To emphasise, I think this is important, to emphasise real life situations when you are doing the space, shape and orientation. Not just show them a triangle, but how it fits into maybe like we did with them with a window, right? Okay, you know, like this is a window within this is just how you can and the benefits of it so they can be more alert to that. Do you want to renovate your

house or something? Then you need to know so that builders won't catch you. This is what I teach them now.

The following lecturer refers to students who are too hasty, misread questions and their over-zealous confidence gives them the false belief that they obtained correct answers. This lecturer would not have picked this up if it had not been for her participation in LS. She mentioned that:

PL1: Yes, I wouldn't have seen that before (before LS) and then another thing that I picked up in the research lesson and was also that students they are very hasty, almost, you know they think they've got the answer. They don't read the entire question then they'll stop midway. Mmm. Then they will only get third of the marks, then lose marks or whatever and don't realise that they must continue and go further. Yeah. So basically, the LS then gave me an idea of how to improve your focus on students more often.

But she also said that this self-confidence can be a positive because you have students who have this self-confidence and just because they think they can do it, they try. She mentioned that:

PL1: Like I said the confidence, I mean, it's not, it doesn't mean that the strongest students necessarily can answer all the questions, but they think they can, and that helps them quite a bit because they'll jot a few things down in the exam, I think, for which they can get marks, whereas students who that are not as confident maybe won't even write down what they think, and then they missed opportunity and that was something that I shared with my classes, when we do revision, we need to build on your self-esteem and you have to do as many examples as possible so that you can feel confident that you know what to do. So, I already shared this with my own classes.

From what lecturers have revealed through their participating in LS and their improvement, it appears that all of them have improved in some way. All of them also confessed that they have never reflected on their lessons in this way and it was an eye-opener for all of them.

Theme 2: LS provides lecturers and managers with reflection on instruction and instructional leadership

Through the LS process, lecturers received an opportunity to broaden their content knowledge, develop new instructional techniques and reflect on their actions to determine what works best for students. Furthermore, the process of LS allowed lecturers of TVET colleges to work together and collaborate, something which is not usually done at TVET colleges. This is because lecturers feel that their lecture rooms are their domain and territory and hence did not allow other lecturers in their space. LS also compelled lecturers to improve their content knowledge through working collaboratively and improved the skill of LS observation as well as reflection and debriefing.

LS rekindled a renewed focus on student-centred learning and teaching as well as an introduction to the problem-solving approach. Furthermore, LS brought about a renewed reflection on lesson planning and on the aspect of anticipated student responses, which was something totally new to the lecturers.

The theme of lecturers' instructional reflection and management instructional leadership has been divided into the following sub-themes, namely: removing the culture of isolation for lecturers; reflecting on the focus LS places on observing students and lecturers; lecturers' reflection on the debriefing stage of LS; LS providing a new focus on student-centred and problem-solving learning and teaching; and focusing on anticipated students' responses.

Sub-theme 1: LS removed the culture of isolation for lecturers

Lecturers, for the most part of their lecturing career, are usually alone in their lecture rooms and the idea of having other lecturers and managers in their classes is uncommon. Lecturers also feel their own lecture rooms are their own domain and space. Lecturers who have participated in this study have revealed that the process of LS has brought them out of isolation, which was very welcoming.

Lecturers were asked what their general impressions were by participating in the LS in this collaborative format.

R: Describe your general impressions and experiences of participating in this LS process.

One of the participant lecturers, IS, for example pointed out that:

> *PL3: As far as my program is concerned, I am like in isolation because I'm working all alone. I'm not used to them (the other lecturers). I only go to so and so for moderation and so on and that's the only things you can do with your fellow colleagues, moderate (assessments) and then we are done.*

The same lecturer further mentioned that because of his exposure to and participation in LS as well as with the manager present, he found that:

> *PL3: At times (before LS) you got scared to go to the manager but now you get to them and other participants to help you with content.*

Another lecturer shared the same view and said:

> *PL4: For me it (LS) was very informative because I could learn professional ideas from my colleagues for example, instead of just being locked in my class alone and isolated. Taking you outside of that daily isolation that we usually experience as individual lecturers in the classroom with the students without others, that is how it is normally done every day.*

Two of the four lecturers mentioned participating in LS in a collaborative format and that it brought them out of isolation and it was mentioned at least five times among them. Although it appears that it was mostly the young lecturers who referred to participating in LS in a collaborative format, they felt strongly about being removed from isolation which also shows their eagerness to learn. One lecturer referred to the fact that, since he teaches ML in a different program than the mainstream program, he feels even more alone and lonely. Removing lecturers out of isolation owing to LS being collaborative and participative also resulted in the professional sharing of ideas and knowledge which is revealed in more detail in the next theme.

Sub-theme 2: Reflecting on the focus LS places on observing students and lecturers

The process of observing students as one of the phases in the LS cycle was a novel idea for many lecturers who participated in the LS process and some reported that this stage was really an eye-opener for them.

When lecturers were asked how and to what extent they have improved their instructional strategies and to describe the specific improvements, many lecturers revealed the stage of observation in the LS process to be significant.

Lecturers were asked the following question by the researcher:

R: How and to what extent have you improved your instructional strategies in your lessons as a result of your participation in lesson study and collaboration in a team?

For example, a lecturer stated:

> *PL1: What I enjoyed about the lesson itself was the observation and me being given the opportunity to just sit and observe, uhm, because when you are in a class you have the sole responsibility of teaching, I could just sit and focus on the case students that were assigned to me to observe. Yeah. I wish I could do more of that. A novel idea.*

Another lecturer echoed the previous sentiment and revealed that it assisted him in focusing on students' weak points and highlighted their misconceptions in space, shape and orientation. It also revealed how LS shifted his way of doing things before and after LS and the improvement.

> *PL3: (Usually) I only observe when I give them a task, but that task could be specific on a certain portion of what I have done. Yeah, so I used to observe, are they doing the work? And how are they performing, but not having (realising) that these can be their weak points and I didn't realise that part of identifying what might be the misconception of space, shape and orientation. I never approached it in that context (observing case students) of knowing, OK what would be their weak points.*

The researcher further prompted him to be more specific with the following question:

R: Describe the improvement and the specific element of the process which facilitated your improvement.

The following lecturer corroborated with the previous lecturer how the observation of LS was an eye-opener to him and seeing things from the students' perspective, he added:

> *PL4: Being a participant in the LS, being part of the LS, I had the opportunity to view one group of three (case) students or so, for me that was an eye-opener and I had a better opportunity to focus more on them and realising that, once I get to my own classroom once again I did it (implemented) with my own students I realised that it will help. The LS process actually provided me the ability to put myself with the students and actually try to learn with them and sit with them… So, I got to see it from a student perspective within a teaching environment.*

The next lecturer was impressed by how the observation part of LS made him reflect on how observation can assist in thinking about it as an alternative form of assessment. He stated that:

> *PL2: Observation has actually a high level of assessment we ever had because we are looking at the student, we can say we have noticed that, or I have observed that, or it seems like there was a problem with this, let's get over that stumbling block quicker because why did students do this and not that. This is the misconception because we observed what these students did and how they did it, how they behaved etc.*

With regard to this, he goes on further saying:

> *PL2: With (an) assessment in my hands, I go blind because I just go on what I have in front of me, and don't have the other knowledge which LS brings forth, like, I don't have how the student approached it, his facial expression, his sighs his frustrations and so on. Because (in LS) we are looking at it audibly, visually and kinaesthetically and through LS we are busy assessing all of it. That is what I am saying; it is a high level of assessment. You can now change your lesson*

because through the observation you realised that there are four more students committing the same misconception.

Although LS focuses mostly on students and their learning, this research also revealed how the observation part of presenting the research lesson not only focused on the student, but also gave lecturers the opportunity to view and reflect how other lecturers deliver a lesson and through reflection on their own lecturing, adjust and amend their own lecturing. The fear of the dreaded appraisal with the manager present in the entire LS process also diminished. It provides an opportunity for the manager to view things in a different way. One of the lecturers mentioned the following in connection with this aspect of LS:

PL4: We were observing the students but when someone delivers (a lesson) you also get some ideas of how he (the other lecturer) does it and how he does it like that etc. And obviously it wasn't for appraisal it was just to be there to see how another person does it. So that also helped me.

The same lecturer went on to point out that:

PL4: I want to say being an observer within the LS process, what's nice this time is that I wasn't part of teaching the lesson. I had to be an observer. I got to sit as an observer, just to view from outside the box in other words because there was, normally I am inside the box, but now I got the opportunity to be out of that box and to see how other people teach a lesson, so for me what was beneficial is getting to see another professional teaching the same topic that I might have done before.

All four the participants, or 100% of the participants, mentioned the observation stage of LS in many different and positive ways and it was mentioned at least 15 times in their responses on various other issues. It appears that the observation stage of the LS process is a positive aspect of LS and a stage from which participants can learn much and improve their teaching and students' learning.

Sub-theme 3: Lecturer's reflection on the debriefing stage of LS

Many lecturers reported that reflecting and debriefing collaboratively on a lesson after it has been delivered is not something lecturers bother with alone after a class is delivered. Nor in a group such as a LS team where different inputs can be heard and inputs and ideas can be used in the next cycle in order to improve the research lesson. Many mentioned that it is really a time to reflect on the lesson in order to improve it and it is time which is utilised well.

The researcher further asked the following question:

R: What other instructional improvements did you make and which of them stand out for you?

The following lecturer stated:

> *PL1: In normal classes we don't reflect on a lesson, we just look at a lesson we gave whatever and that's it, you tick it off. But we never reflect, but in LS it at least gave you that time to reflect and collaboratively to reflect and each one has a say in the debriefing stage and see how this lesson was delivered. Usually, we don't do that. That will make more effective use of your time and often we spend so many hours and minutes on a topic and then it's gone to waste and students didn't retain the information.*

The following lecturer adds his voice and also points out that it is important not just for lecturers to reflect on a lesson, but also for managers to become directly involved to encourage lecturers to implement it in their lessons and to collaborate. He mentions for example that:

> *PL3: When we deliver a lesson, we come and discuss back (debrief) where those things like the misconceptions we thought of, did we get it? Like it in the times of what we're doing there as much as we have the debrief and reflection which is an important part for managers to look at. And important for managers to get involved and encourage lecturers also to reflect on their lessons maybe in a collaborative way*.

This same lecturer emphasises the debriefing stage further by stating:

> *PL3: It is about planning and deliver and come back and plan again then to improve so it always works on that way.*

Two of the four participants commented about the debriefing stage of LS and it appears that it was taken as a very positive aspect of LS and teaching and learning which lecturers did not think about much. It was also seen as an important aspect for lecturers to reflect on their instruction as well as for managers in terms of instructional leadership. The aspect of debriefing and reflection was roughly mentioned 14 times.

Sub-theme 4: LS provided a new focus on student-centred and problem-solving learning and teaching

Being part of the LS team, collaboratively planning lessons and being part of delivering lessons and observing students doing work in a student-centred approach, provoked a new sense of emphasis with lecturers and the manager on the student-centred approach as a form of teaching and learning and classroom management. Student-centeredness was seen through new eyes. This can be used by managers to encourage lecturers in ML and other subjects to use it in their classes at TVET colleges in a more structured way through the vehicle of LS.

The researcher asked lecturers further questions on their impressions and experience on being part of LS. The following question was asked:

R: How did the LS process improve your ability to focus on how your students think and learn? If it did, can you give an example? If it did not, please explain why not?

The following lecturer mentions how the students enjoyed the group work and how she also enjoyed the walking around as a facilitator. This lecturer also reiterates that the topic of space, shape and orientation in ML is a topic most students struggle with. For example, she explains,

> *PL1: I could see how the students enjoyed the working in groups, because we don't often let students work in groups; for example, it was nice to feel the vibe*

from the floor, they were very encouraged, and in the interview with the students they also liked the student-centred approach and they were actively involved. They did not get everything correct but they were inspired and the lesson went by pretty quickly and I think we can have more of it (student-centeredness). It was nice to see that the students can actually enjoy ML and space and shape which is normally a topic that they dislike.

She continues:

PL1: And then also the positive thing was for me how the lecturers and students really engage and got engaged, how they got involved and how much they enjoyed it.

The following lecturer mentions that he found the adoption of the student-centred approach in his classes as an improvement in his instruction and reflection. Furthermore, he likes the idea of the student-centred approach being instrumental in making the student an independent student and whose confidence increases. For example, he concludes that,

PL4: OK so what I liked about the LS is that it does take on a problem-solving approach as well as a student-centred approach, which gives the student the opportunity to actually sort of having learning in their own hands. So having learning in their own hands gives them that responsibility for their own learning which I found an improvement from my way of teaching.

PL4: I would say what I learnt also is ah sometimes the student can actually guide another student in a group work effort instead of the lecturer being the one to play the facilitator, so what I am saying is what I am learning from this is that sometimes it's also good to provide those students with independence in their learning… because now they have to speak in front of the whole class whereas having certain groups, they would then have the confidence to speak within a small group.

The same lecturer saw the value of using student-centred learning during and after the LS was completed.

PL4: Uhm an element that I had used and emphasised more on was the student -centred approach, not necessarily putting them in groups because of time constraints but I have used the student-centred approach and problem-based questions as well and what I have done actually, I have taken questions from past exam papers and I would give it to them and I would tell them to solve it using their books as a guide, giving them less information like we did in our LS for data handling as we are busy with it now.

The following lecturer corroborates and mentions that it also changed the way he delivers lessons in a student-centred approach and that it challenged the students, but also challenged the lecturers. For example, he states:

PL2: You are starting to challenge them (through problem solving and student-centred learning), and you you're starting to appreciate them also and their knowledge because you are thinking you must just transfer knowledge all the time, but sometimes they have knowledge themselves and different methods how they approach it and you can appreciate that.

PL2: But LS challenged me, you know to go even further to challenge the students even further, their intellect, and to push it even further, their critical thought. I had I think because we had a problem-solving and student-centred approach like where you have more than depending on the students to come up with the answer. I think that was really good.

Three of the four participants, or 75% of them referred to the student-centred and problem-solving approach used in this LS and all of them had very positive experiences. One participant mentioned how students enjoyed it and the engagement between students and lecturer. One mentioned the independence and confidence that increased in students, while the other referred to student-centeredness and problem solving as a good challenge for students as well as for lecturers. The concept of student-centeredness and problem solving was mentioned at least ten times by these lecturers.

From the two student interviews that were conducted, one with selected students after the first cycle and another after the second cycle, it was revealed that students enjoyed

the LS in general, and liked the student-centred approach most. It was also revealed through the interviews that they would look differently at questions and how they would interpret them.

After the first cycle of the LS when a cohort group of students were asked by the researcher what they enjoyed most about this lesson, students had the following to say, namely: (S11- student 1 after first cycle; S21 – student 1 after second cycle)

> *S11: Would like more of these LS processes so that more things can be observed by lecturers. If lecturers can go around and see what students are doing wrong.*
>
> *S12: Do more of these types of sums.*
>
> *S13: Teamwork, learn better from peers.*
>
> *S14: Working with each other is better than working alone.*
>
> *S12: Lecturer interacting with student.*

After the second cycle of the LS when the students were asked by the researcher what they enjoyed most about that lesson, students had the following to say:

> *S21: The engagement with students and with lecturers.*
>
> *S22: And the engaging, sir, you see when it comes to ML, we don't normally do group work, we normally do individuals, so my group work skills were lifted (raised).*
>
> *S23: I think someone has mentioned it before, but the questions, you really need to read the questions properly. And the engaging, sir, you see when it comes to ML, we don't normally do group work; we normally do individuals, so my group work skills were lifted.*
>
> *S22: Because I had the opportunity to engage with my fellow students and engage with the L as well as the observers.*
>
> *S23: Sir, my error in thinking, Sir, is confusing calculating perimeter for certain shape with area for certain shape because it is more or less the same, so instead*

of using a plus I used to put a multiplication sign, so confusing signs, so confusing multiplication and plus when calculating perimeter and area.

When students were asked in the second interview whether they would like more lessons involving student-centeredness, the next student answered as follows:

S22*: Yes, maybe twice a week.*

The researcher also requested participants to maintain their own journals throughout the entire process of the LS for all meetings, research lesson discussions, observations, debriefings and lesson deliveries. The following are some comments which participants documented in their participant journals regarding the student-centred and problem-solving approach adopted in this study.

PL4: This session was useful because we received a clearer view of the actual lesson to take place. The lesson will take place as a student-centred approach.

PL4: Lesson plan improved. Students will be more prepared for student-centred and problem-solving approach.

PL1: Students will be motivated to solve the questions, as it is a new approach for them.

In his journal the researcher documented the following:

R: Lecturers understood the methodology (student-centred and problem solving) and the purpose of the meeting. Contributions are clear and valuable.

Sub-theme 5: Focus on anticipated student responses

The following lecturers mentioned how the concept of the anticipated student responses, which is used as a standard format for most LS research lessons, would now assist them to improve their lesson plans. It also showed lecturers to reflect much more and more deeply on their lesson plans and have the student uppermost in their minds, something lecturers do not always do. For example, they mentioned:

PL3: Well, one would now know how to structure the lesson and it helped me. Because now I will be able to know, okay as much as I will teach ABC what are the things that will come up that I would expect (anticipate) the students to do. The thing that might come up so it helped me to actually highlight those things in my lesson plans and the misconceptions they also helped me on that area, uhm and also and in terms of delivering the lesson. I think now I have a clearer picture.

The following lecturers had the same view and they stated that,

PL2: It (LS) shows that you can predict actual responses from the students and maybe what you can do, you know what I'm saying? So, it makes you think, it makes you critically think about your lesson plan.

PL1: I think breaking the lesson plan up into time slots of like five- or ten-minute chunks. And then also the anticipation of what the students are going to answer. I don't think that's always something, people pay a lot of attention to when they plan their lessons. Yeah, I think of with having taught this for a couple of years, I mean, it was like I could almost anticipate what the students were going to do.

The following lecturer mentioned that to anticipate students' responses when planning a lesson made him become more proactive and previously something never thought of. He mentioned,

PL4: Being proactive. LS always asks what do I anticipate? Predictions according to my experience with my learners and topic expectations, but I would never have voiced them or focused on them if it wasn't for the LS. It gave me foresight, never thought about these aspects before the LS process. Pre-LS was usually about method, content and simplifying it. I improved a lot because of this aspect of LS (to anticipate, predict). Anticipation etc. is a powerful aspect of LS.

PL4: Writing down student expected responses (and misconceptions). It helps the teacher to address those responses during the teaching process as well.

The following lecturer corroborates the previous lecturers' view and adds that the manager participating in the LS assisted him. He states:

> *PL3: What I picked up from the manager, the experience was writing down student expected responses (and misconceptions). It helps the lecturer to address those responses during the teaching process. I never thought of that all this time in my career as a ML educator. I will definitely use this in the future in my lessons to say what do I expect my students to do and then categorising the students according to the misconceptions (in space, shape and orientation).*

All four participants, or 100%, mentioned the anticipated student responses and most of them found it to be an eye-opener and something which was not paid attention to previously in their lesson planning. Most said that they would use it in future. Among the three participants who mentioned this it was mentioned roughly fourteen times.

As far as the participants' journals are concerned, the following were comments and experiences of interest as far as anticipated student responses were concerned.

> *PL1: Great to anticipate student responses and improvement of lessons. Inspires us lecturers to evaluate different approaches in order for teaching to have optimal effect. Very insightful and inspirational.*

> *PL2: There is so much scope for improvement in our own lesson plans.*

> *PL4: I learnt other views of lesson planning such as the anticipated student responses.*

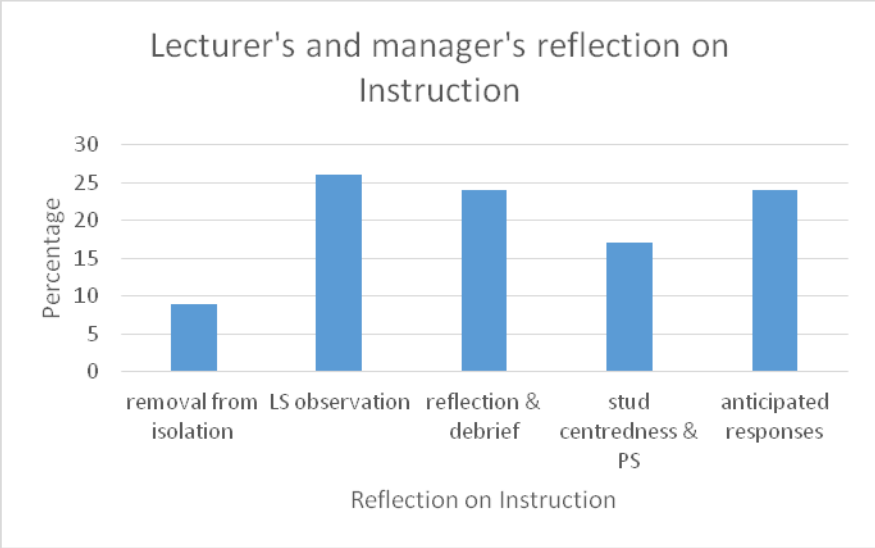
As we were entering the last meeting and discussions finalising the research lesson for the first cycle, these participants recorded the following in their journals:

PL4: Exciting! The assessment and research lesson is taking a student-centred approach. Can't wait to see the lesson in action!

PL1: We are getting closer to a refined lesson with only a few challenges.

A chart recording the comments above shows the results of how the LS approach can provide reflection for lecturers as well as for managers.

Figure 5.8: Lecturer's and manager's reflection on instruction



From the chart above it looks like participants in this LS process benefited more from the stage of observation in the LS process than any other, although reflecting on the anticipated responses and reflecting and debriefing of a lesson after the research lesson had been presented, scored the same; it is slightly less than observation. All these concepts are also new to lecturers in terms of teaching and learning and hence it enjoyed more attention from them. It is interesting to note that the aspect of isolation scored low and it was mainly the young lecturers who mentioned this indicating that young lecturers are left on their own when they start. This is something managers should be thoughtful of.

Theme 3: Creation of an open organisational culture through collaboration and participation in LS leads to organisational effectiveness

Collaboration and participation are at the heart of LS. As one of the participants mentioned, "*Collaboration is LS, so you should not ask how is LS, you should ask how is the collaboration*". Furthermore, LS can also not take place without participation and most of the aspects of participative management comes into play in LS, such as creating an open organisational culture, sharing ideas and knowledge, the cultivation of respect and trust among members, creating a positive, non-threatening and non-judgmental atmosphere and an environment in which decisions can be made freely.

The sub-themes identified under this theme were: LS led to healthy discussions among participants; LS encouraged the sharing of ideas among lecturers as well as among managers and lecturers; LS encouraged openness between lecturers and manager(s); LS brought about trust and respect among lecturers and managers through the process of collaborative participation; the open culture developed through LS encouraged positive relationships owing to the non-threatening and non-judgmental approach of managers.

Sub-theme 1: LS led to healthy discussions among participants

LS provided an excellent opportunity to all the participants in the LS team, including the younger lecturers, to have healthy communication, discussions, debates and critical thinking in a very mature setting. This resulted in good sharing of professional knowledge and expertise between lecturers and managers, both as far as content is concerned and knowledge about students and classroom management. At the same time, it also provided the manager a glimpse of how LS can be used as a platform to encourage healthy discussions among lecturers and managers in a positive atmosphere, as well as possibilities for all managers to learn from this.

When lecturers were asked what their general impressions and experiences were in participating collaboratively in this LS, they had very positive responses. Many lecturers mentioned the discussions that ensued being part of this LS when the following question was asked:

R: What impact did it (LS) have on you to be part of a team in the LS process?

For example, the following lecturers stated:

> *PL2: I think it is very good, for myself but also for the younger lecturers, so they can discuss and we can discuss, So, it challenges you to think critically, we have to argue (about content).*
>
> *PL1: For me the discussions with the colleagues was actually really a great experience because we don't often have time that we set aside to discuss lessons.*

Another lecturer mentioned how LS collaboration leads to a deep level of discussion on content, questioning techniques, delivery, classroom management and terminology. For example, he pointed out:

> *PL3: But we never (normally) get to discuss the content, where we sit down together and say, okay this is a circle and then what kind of questions (to ask). OK and if we develop a question like we say we don't say calculate the area, (instead) we ask how much material of cover will you need. You see we don't say those kinds of things. It never comes to my mind. Or, I think that will help me now in the case of the classroom, just to emphasise when I'm teaching to emphasise this is the area.*

The same lecturer points out the importance of managers' involvement and for them to learn from what emerges when misconceptions are discussed.

> *PL3: They are basic misconceptions for this part, because when we're doing these, like this project, we take one question, we analyse the misconceptions for that particular question. So, that's what I was not doing before and managers can also learn from that, by taking us as lecturers on working together and then analyse the questions together at times when the time allows to discuss and come up with something.*

The discussions which continued post-LS were also highlighted by some lecturers. For example, lecturers mentioned how easy it was for them to continue with discussions post-LS. For example, two lecturers referred to this in the following way:

> *PL4: We shared and discussed our experiences after the lesson took place, before the debriefing with the manager (researcher) and there was also an informal debriefing with each other and beyond LS.*

> *PL3: Even after the LS process, I found it so easy to discuss content issues and matters much easier with my colleagues at the campus and this is a plus which came from the LS process. This is now done more regularly and previously I only looked at my colleagues and never interacted and engaged with them in this way.*

All four participants, or 100%, in this LS referred to how the participation and collaboration through participating in LS brought about sound and deep, healthy discussions, debates and arguments around content and context in ML. Two lecturers mentioned that it even continues after the LS had been completed. The four participants referred to the concept of discussions at least 15 times.

With regard to the aspect above, the participants also recorded the following in their participants' journals:

> *PL2: Very participative. Lecturers interacted well and there was a lot of enthusiasm. Enjoyable and fruitful.*

> *PL4: It is interesting to view work of professionals.*

In the researcher's journal in the second cycle of meetings and discussions to revise the research lesson, he recorded the following:

> *R: Good and healthy debates were going on without one over-powering the other and each one gave a hearing to everyone. Constructive and healthy discussions were taking place in this session.*

Sub-theme 2: LS encouraged sharing ideas among lecturers as well as between managers and lecturers

The collaborative and participative nature of LS encouraged sharing ideas in most, if not all, the stages of the LS process. It was also a powerful way to obtain the views and opinions of fellow colleagues on issues such as lesson planning, observations and the debriefing stages.

For example, lecturers were asked the following question:

R: To what extent did the involvement of the researcher (manager/ education specialist) as a participant observer in every part of the lesson study process impact on the improvement in your instruction and lesson plans?

For example, the following lecturer points out how important sharing ideas is in connection with lesson plans:

> *PL1: So, I felt that the sharing of our ideas was very good. It was very good hearing other people's input, their views, their opinions, their approaches, uhm and yeah, and then I just realised more and more that lesson plans need to be a priority. You know, that is the basis that our lessons will be shaped on or formed on. So, yah I really enjoyed listening to my other colleague lecturers and my colleagues. That was a good experience. I think the sharing and the opportunity to work together and be creative together and share ideas.*

The next lecturer emphasised the sharing of common experiences between participants and the manager of the LS process. For example, he mentioned,

> *PL4: We get to share common experiences uhm. Which I thought was uncommon experiences actually were common experiences in terms of students learning inside of the classroom. We became more open to share knowledge with other people, including managers.*

In the next section he reiterates how important this is in terms of teaching and learning and for the whole TVET sector:

*PL4: For me the greatest benefit was the sharing of experiences that were common to my experiences and getting to learn how the other colleagues (participants) would teach and learn by questioning, for example. That is what I enjoyed about the LS process, is that in teaching a lesson sometimes questioning students can also be better than just giving them the introduction, rather to question them and have them take a major role in bringing the introduction into the lesson. S*o, *I would say guaranteed that LS is a benefit for the entire TVET sector, because professionals of different ages get to share their experiences with each other.*

The next lecturer alludes to the previous lecturer and states,

PL2: I know when I do this, students are going to do that and so on, or this is what they usually do, and somebody in the group can come along and say what you do is this and that. This is what I do. So, they have to work out a strategy to use whatever works within so they have a platform to share things about classroom management.

All four lecturers, or 100%, commented very positively about sharing ideas that LS affords in various ways, such as in teaching and learning, sharing knowledge and working together. The four lecturers referred to the concept of sharing at least 12 times in their discussions.

As far as the participants' journals are concerned, the following were comments and experiences of interest as far as sharing ideas and knowledge is concerned owing to collaboration and participation between lecturers and between lecturers and the manager.

PL4: The collaborative approach brings in new ideas as it stems from a collective input of experienced professionals.
PL2: Working together, you learn from others. The group has a lot of experience.

PL1: Great experience to share views and ideas with colleagues, taking students' interest to heart.

PL2: Sharing ideas in the meetings was good.

Sub-theme 3: LS encouraged openness between lecturers and manager(s)

For lecturers to be open with one another when discussing and sharing ideas, and knowledge for issues and matters related to the content in ML, as well as being open at every stage of the LS process, makes the process of LS smooth. Openness from the manager as well as openness toward managers in the LS process makes participating with one another collaboratively and working in a team powerful and constructive. The collaborative and participative nature of LS requires all the participants to be open and cordial toward one another. In order for the LS to be successful and the goal of the LS to be reached, it is also important to maintain open relationships. This must be so, not just between the participants of the LS team, but also between participants and the manager and vice versa.

The following comments were made when the researcher asked the following question:

R: How did the participation and the collaboration between the participants together with management in the LS process bring about an open, positive and supportive environment and how did your relationship with your manager change through the process?

The next lecturer points out that

> *PL2: You (the manager) must be open-minded, you must be professional. So, you must, important you (managers and lecturers) must have an open mindset to enable this to work.*

The same lecturer goes further mentioning the importance of the leadership of the manager and his/her engagement with the other members in probing further into issues. It also indicates the manager's ability and the need to keep the LS and discussions on track. He stated:

> *PL2: What the other people and you (researcher) were very good at, is asking. What do you think, what you think about the process so far, what can be*

changed? Are you happy with this? You gave feedback here and getting feedback is very good. And if you don't do that within the lesson study then you also going to lose out and the participant will say I don't want to come (participate) anymore.

The researcher also asked whether some felt restricted in any way because of their other more experienced lecturers' superior knowledge.

R: Do or did you perhaps feel restricted in any way having more experienced lecturers and the manager in the LS team?

This lecturer mentioned that:

PL1: Yeah. I don't think the participants had a problem with that and for me as well, I would like to think that we've always had this open relationship if you want to call it that way. Uhm, so now I don't feel that I was restricted actually like before.

PL3: We… everybody listened to each other's ideas, like everyone was given equal opportunity to share their experiences and their ideas in terms of the content.

The same lecturer mentioned that there is an open approach to go to other lecturers and the manager to learn something new, such as a reference to a book or learning about a new software which he never knew about or knew how it worked and through collaborating and participating in a LS process, assisted him in it owing to the openness which LS awakened in him. The lecturer, for example, pointed out that:

PL3: And then approaching someone for, that's Geogebra (a software for ML and Mathematics) and this you learn some stuff and then when they, someone said there is a certain book that you can use, all because of the openness of lecturers and the manager(s).

On the issue of learning from others as far as software packages are concerned, the following lecturer also echoed the view by the previous lecturer in his journal:

PL2: I learnt about Geogebra from the LS group.

The culture of openness also engendered a culture of improvement in lecturers owing to their being observed and their observing other lecturers delivering lessons.

> *R: You mentioned about observing. How do you feel about other lecturers observing you?*

He stated:

> *PL4: It's becoming more open and I didn't feel any problem, other lecturers fear observing you in class. LS brought this about. Yeah, I think it will help like to observe other people how they do as much as you know how to do, so you are more open to improve, the aim is to improve.*

When asked what the benefits were for him regarding LS, the following lecturer mentioned:

> *PL4: We become more open to share knowledge with other people… and sharing knowledge with each other was done so in such a friendly manner and an open way that, which for me was very beneficial. The LS process created the platform for us to converse with each other in an open and trustworthy way and I would say definitely that this should be a process that can be implemented within the TVET sector.*

In connection with the above statement, the researcher also recorded the following in his researcher's journal in the second cycle of the LS.

> *R: There was constructive and very interactive engagement and a few misunderstandings were cleared.*

All the participants, that is 100% of the participants, reflected positively about the openness that did and must prevail in the LS process among lecturers and between lecturers and managers. It appears that participants realise the value of having an open relationship in order to cultivate an open culture at TVET colleges. This aspect of LS was mentioned 20 times by the participants.

Sub-theme 4: LS brought about trust and respect among lecturers and managers through the process of collaborative participation

Trust and respect are important aspects which must permeate through all the stages for the LS process to be successful and all the goals to be reached. Trust and respect must be present between lecturers and between lecturers and management. In this study it was revealed that trust and respect played an important role and most participants regarded it as important and essential for the LS to be successful.

When lecturers were asked to what extent did the LS process with the manager (researcher) as a participant bring about respect and trust between lecturers and between lecturers and manager, the responses were varied, but positive.

The researcher asked participants the following general question:

R: In which way and to what extent did the LS process through participation and collaboration bring about respect and trust among the members (lecturers and the manager)?

The following lecturer, for example, pointed out that he learned to value his colleagues; his relationship with his colleagues and the manager improved. He stated:

> *PL2: This (LS) also resulted in participants respecting one another more so you learn to value people. You will also see like my relationship with my fellow colleagues also improved and with you (researcher as manager) also it improved.*

The same lecturer warned that managers do not take the position of the 'know it all', but listen carefully to subordinates' views as well. He reinforced by saying:

> *PL2: Like you (researcher and manager) never did say I know everything, but the manager listened and you respected what the other people and you (researcher) were very good at, is asking. What do you think, what you think about the process so far, what can be changed? Are you happy with this? You gave*

feedback here, getting feedback and that was very good. You respected that person even though you are the manager you are colleagues in that process.

The following lecturer corroborated the previous participant's views and mentions:

PL1: Like I said before, I think the respect that we feel that everybody's got something to contribute. I mean you've got different experiences, you have different personalities, uhm, but I mean together we've got the same goal and it's almost as if the team is more representative of what we deal with in the classroom because you also sit with different personalities. And you have different classes and you can bring that into the discussion. And the trust. And so on, that's what I think.

The same lecturer continued by saying:

PL1: And so y'all I also think, I think the sharing and the opportunity to work together and be creative together and share ideas, also the respect I think, we respect each other and despite experience or lack of experience.

The trust that ensued between the lecturers and the manager also penetrated into the trust whenever assistance was needed and lecturers could depend on and trust one another to assist in terms of obtaining help with issues from one another, such as software and geometrical drawings in space, shape and orientation. For example, the following lecturer highlights:

PL3: When someone is saying okay, I will draw this structure (drawing) using a certain software. So, I trust that, okay. Whenever I struggle, I know there is someone who is saying that there is something (software) that can assist me.

He continued:

Everybody trusted one another and respected one another. We like it was interested in one another, we respected one another.

The following lecturer emphasised the importance of the trust and respect aspect among the lecturers, but also among lecturers and the manager when being part of the LS process. At the same time, he mentioned how the sharing of experiences about

teaching and learning itself and other experiences through collaboration and participation among lecturers brought about growth.

> *PL4: Ok, uhm I would say it brought about great trust and relationship between us because of sharing our experiences with each other before and after the lesson has taken place both on an informal and in a formal manner uhm getting to hear that there are common experiences as well as uncommon experiences. There was respect for my views and vice versa and the LS is a good platform for bringing about more respect and trust among colleagues and among colleagues and managers. The LS process provided an opportunity for trust and respect to grow because we, as an example, I can say no one spoke over each other's words.*

The lecturer was further asked the following question:

R: Did working together in collaboration and participation bring lecturers closer together?

The same lecturer said that it also brought about co-learning and he mentioned:

> *PL4: Everybody had a fair opportunity to speak and share their perception of teaching and learning and having the opportunity to share their experiences also brought us closer. I would say it brought us closer together, for example, I got to be with a lecturer that is not only in NCV, he is also in a different program teaching Mathematical Literacy and through the LS process I got to interact more with him which I never did before and this brought about great camaraderie among lecturers teaching in different programs. In the process I learnt from him and he learnt from me.*

Another lecturer also referred to the camaraderie, which aids co-learning between lecturers and manager, which developed between them when he spoke about trust and respect.

PL2: There was this great camaraderie between participants which was good and this also resulted in participants respecting one another more. This was a direct result of the collaborative and participation present in LS.

The researcher also observed the issue of camaraderie that developed among lecturers and between lecturers and the manager and recorded it as follows in his researcher's journal.

There was a positive camaraderie and there was good collegiality developing between colleagues and manager. Participants were also excited to see the next revised lesson.

The following lecturer reiterated the respect and trust that was built between lecturers, but also between lecturers and the manager. The manager also learnt from the process, not just the lecturers, as the manager became a co-learner in the LS process. For example, he pointed out that:

PL3: For me that (LS) is and was powerful. It builds trust to the process. It builds trust for the lecturer. It also gives the manager the clear picture of really where his people are at. What we are saying, what each one was saying was respected. Different views were respected and it is co-learning and even the manager learns.

All four participants in this study reported strongly and positively about the respect and trust that LS brought about between lecturers and between lecturers and the manager. The concept of trust and respect was mentioned eighteen times.

Sub-theme 5: The open culture developed through LS encouraged positive relationships owing to the managers' non-threatening and non-judgemental approach

Usually, the presence of a manager in a classroom creates a threatening atmosphere and creates a perception in lecturers that the manager is there to appraise and to pass judgement, even if the manager is only popping into class. This is a perception that must be removed in education institutions, especially in TVET colleges in order to move

forward. The LS process is a powerful mechanism to achieve this. Findings from this study revealed that the involvement of the manager in the LS process led to an open, non-threatening and non-judgmental approach which resulted in freedom to make decisions and this led to empowerment of lecturers. The power of subordinates for free decision making in a non-threatening and non-judgmental atmosphere and environment is fundamental in a participative and collaborative relationship such as a LS. When this happens in a supportive and positive atmosphere it results in greater success.

When asked how the LS brought about a positive environment and in which way they experienced the manager as positive and supportive, the following lecturer, for example, said on different occasions:

> *PL2: Yeah, like I said the lesson study is very positive for myself and you bringing it to us that already sets a nice positive platform for us to venture forward. Uhm, and with the colleagues.*

> *PL2: Look I'm relatively new in maths lit, second year, I think. I don't know the managers too well, so I got to know you as being very supportive, very positive. So, I like that. I like that you are driven like you want things done and you want to change things. So, that says it's very positive. So, I would say it's a very positive thing; it did give positive vibes. The vibe is better, yeah, the vibe is better. I am now friends with them (colleagues) and they will now pop in here and ask how is it going and it is very positive so there is like a positive vibe and our interactions have improved in a big way. Okay, I think there was a good spirit. It was a positive and the other thing is there is a nice synergy developing between us.*

Lecturers were further prompted with the following question:

R: How did the participation and the collaboration between the participants together with management in the LS process bring about a positive and supportive environment and how did your relationship with your manager change through the process?

Lecturers answered as follows:

PL1: I think this a great opportunity for managers and lecturers to work together and it was never done before, and I think you must embrace the fact that other people also have input. So basically, then I would say it was positive in support of it. It was a supportive because we have that positive relationship here at this campus as well. So, I would say participation and collaboration brought about a positive relationship and supportive culture.

The following lecturer echoed the lecturer's views and said:

PL4: It provides an opportunity for professional individuals to actually work together on a specific topic to develop professionally because it will provide a mutual development for all lecturers involved as well as for the manager because now the manager gets an opportunity to actually share and to view our (lecturers') experiences inside of a classroom and in that way it actually builds a better relationship because we are now more involved, we socialise more on a professional level as well as a personal level.

When speaking about their experiences of LS, working together and in participation, lecturers mentioned the positive attitude which developed between team members. For example, the following lecturer pointed out:

PL3: Firstly, especially the teamwork. It developed like a positive attitude towards working together (with each other) because it brought us out of isolation.

The same lecturer was further asked about how it feels to work together versus working alone (or in isolation) through the following question:

R: So, what benefits were there for you working participatively vs. alone, for example, when we planned a lesson?

He mentioned that it helped him in building a great relationship with the manager(s) and their approachability which all resulted from participating in the LS. For example, he said:

PL3: So, it helped me to know and to have a better understanding of my manager. Yeah, to work with you (the manager) as well, because I used to have

some image, but now I know that at any time you are the person that I can approach. So, working with the managers helped me to have a different idea about them. So, my relationship with the managers improved quite dramatically for the manager being part of the process is what benefits. It brings about the positive atmosphere working in a lesson study group now, that's what I'm saying. Like now I even have a different view of my class.

On improved understanding and relationships between lecturers and managers the same lecturer proceeded to say:

PL3: We are understanding each other better, because at times you perceive the manager as someone who will identify faults. So, I think it will help not just the manager but all participants also to be open to suggestions and allow the manager to make mistakes as well. And when we work together, we can help them as well and they can help us as well and create a positive atmosphere and a supportive atmosphere among the colleagues.

On the same question asked about working alone versus in collaboration and participating with others in all the phases of LS, this lecturer said the following:

PL4: And we become more open to share knowledge with other people and that was what was very positive and very good because nobody was hiding anything and sharing knowledge with each other was done so in such a positive, friendly manner and an open way that, which for me was very beneficial, because it made me think more positively in aid of teaching and learning.

PL1: Relationship among its members is positive then LS will be a success and efficient.

PL3: So, it helped me to teamwork, it helped me to understand them (lecturers and managers) better and it also helped me to understand my students better and the lecturers (participants) better. That was because of the collaboration.

The open and positive culture was also enhanced and encouraged by the non-threatening and non-judgmental approach of the manager in most of the stages of the

LS process. This further helped participants to give their best and ease into the collaboration and participation in the LS process.

> *PL4: Everybody is involved, the manager is involved, lecturers are involved and students are involved and that forces a manager also to become more involved in the classroom of the lecturer without feeling threatened by the manager and that is also something that definitely came out from this LS process. I did not feel threatened by the manager (researcher).*

On this the lecturer went further, saying:

> *PL4: It was non-threatening, because normally a manager will come to your classroom for an appraisal, but here the manager was one of us, and I think on that note it definitely brought in a positive experience because we (manager and I) got to share our experiences afterwards as well.*
>
> *PL3: Yes, indeed I felt like we are the same colleagues all on the same level, all the colleagues were on the same level so I did not fear (non-threatening) there is a manager and there is a lecturer. In this LS procedure there was no difference.*

All four participants, that is 100%, referred to the concept of the positive relationship which developed between the participants and the manager in one way or another. All of them also referred to the fact that LS provided a great platform for participants and managers to participate with one another. The four participants referred to this concept 24 times.

As far as participants' journals are concerned it is interesting to note that one of the lecturers experienced the entire LS process as *ubuntu* when considering the openness it inculcated. They concluded in their journals that:

> *PL2: It's got a lot of community of practice in it. Ubuntu.*
>
> *PL4: A positive learning atmosphere for all participants.*
>
> *PL4: All positive! As each session takes place, lesson becomes more and more articulated.*

The results can be indicated as follows in a pie chart.

Figure 5.9: Open organisational culture of collaboration and participation

According to the pie chart above, the aspects of positive relationships, openness and trust and respect scored quite high, with positive relationships scoring the highest (27%). This clearly shows that lecturers found LS a collaborative and participative approach to teaching and learning, resulting in a positive atmosphere and the visibility of the manager in this process assisting in this process. The aspects of openness, trust and respect also aids in bringing about this positivity and it is clearly seen that the one cannot exist without the other. This is supported by literature as will be elaborated on in the discussion in chapter 6.

Theme 4: Personal and professional improvement and empowerment

The power of working collaboratively and in participation with colleagues led to participants increasing not only their confidence but also their motivation. Lecturers mentioned that this has resulted in their overall improvement and they felt more empowered than ever before. This came about owing to their confidence and self-esteem in the subject ML and especially in the topic of space, shape and orientation improving, as well as their personal improvement. Lecturers also revealed that they now feel more motivated toward the subject and in general.

Theme 4 is divided into two sub-themes, namely LS empowered lecturers to increase their confidence and motivation and LS empowered lecturers to make decisions freely.

Sub-theme 1: LS empowered lecturers to increase their confidence and motivation

Working collaboratively and participatively in a team, such as a LS team, boosts confidence and self-esteem because every participant in the team has an opportunity to give input and no idea is regarded far-fetched or ignored. Hence, this motivates members in a team to do better and this eventually empowers them.

In relation to the above statement the researcher asked the following questions of the lecturers.

> *R: In which way did the sharing of ideas and knowledge in the LS process increase your confidence, and how did it motivate you?*

The following lecturer mentioned:

> *PL3: I cannot explain in what way, but I think I'm kind of motivated, I'm kind of motivated and I am more confident now in the ML subject. And this LS process helped me in doing that, yes. Well, it motivated me in the sense of when I have anything in which I am struggling I should know who to approach.*

The following lecturer (who is a young lecturer) has the same view and mentioned in addition that it also boosted his confidence participating in LS process and he gained more professionalism. For example, he stated that:

> *PL4: Yes, definitely, I can start by saying LS process did motivate me and my confidence has also increased as well, so it is all positive and what motivated me is when we shared our experiences after the lesson took place, before the debriefing with the manager (researcher) there was also an informal debriefing with each other as well which I found to be motivating… it also boosted our confidence as a professional individual and gained more professionalism as well.*

The following lecturer mentioned that besides LS increasing confidence in her and motivating her, it also increased confidence and self-esteem in her students as well. For example, she mentioned:

PL1: But what I did pick up was the fact that so many students, like I said, the confidence and self-esteem of students increased… And for myself it did motivate me and confidence, yah confidence, maybe in reading students better and I think in that sense to try something new, a new approach but yah and it was just the fact that students can still enjoy. You must just put in a different approach but I don't think confidence in the sense of how I will necessarily teach that because something that I'm pretty sure, the topic that I'm pretty confident with.

The above lecturer's view was also corroborated by what students reported in the interviews the researcher conducted, although the words *confidence* and *motivation* were not used, what the students below are reporting can surely be revealed as confidence and motivation, because they could do perimeter and areas better through LS and one or two students reported a motivation to do better. When students were asked, "What can you do now (or do better) that you could not do before?", the following students, clearly showing confidence and self-esteem, for example, stated:

S12: Make mistakes, sir, don't be frightened to make mistakes

S21: Don't be afraid to ask for help

S22: Calculating areas better than previously

The following clearly shows a motivation by students to do better:

S11: Go over your work every day just for an hour or so.

S12: Practise.

S23: Engage with others (fellow students)

S14: And try to memorise all these formulas

The following from a participant's journal clearly showed how this lecturer feels that, owing to this study, students will also become more motivated in this new approach adopted in the study.

PL4: Students will be motivated to solve the questions, as it (LS) is a new approach for them.

The following lecturer cited an increase in motivation, not only in her, but she also noticed the increase in motivation in her colleagues as well. For example, she mentioned:

PL1: Like yah we had good people in the group, people who know what they're doing and they were enthusiastic. They became motivated.

The following lecturer expressed the same view as the previous participants but adds that he found the debriefing stage motivated him and brought confidence. He states that:

PL4: Yes definitely, I can start by saying LS process did motivate me and my confidence has also increased as well, so it is all positive and what motivated me is when we shared our experiences after the lesson took place, before the debriefing with the manager (researcher) there was also an informal debriefing with each other as well which I found to be motivating.

The following more experienced lecturer mentioned that he is already confident as a ML lecturer and that LS did not impact that much on him being a confident lecturer already, but in many other ways about LS. He mentioned, for example:

PL2: I am fairly confident. Okay. Yeah, so it didn't impact me all that much. You can learn and engage and that makes a little bit more confident in a sense when you look at other people's methodology.

The following lecturer mentioned that the two younger lecturers in the team were quiet at the beginning, but later on in the LS process and stages, their confidence and self-esteem really improved. For example, she pointed out:

PL1: (Referring to the younger colleagues). They were younger. At the beginning they were very, very quiet. Afterwards they came into the rhythm of things that yeah, I think they still have sort of the feeling that they must learn from the more

experienced lecturers. But I mean they had very valuable input to give themselves and their confidence also improved.

On the aspect above about the younger lecturers being quieter and not giving as much input in the meetings and discussions than the other two, the researcher also observed this behaviour and documented in his researcher's journal the following in one of his earlier LS meetings:

Observed and noticed that two participants were passive in the meeting, until researcher prompted a few reactions from them.

In one of the later meetings the researcher documented the following in his researcher's journal:

Two of the participants who were initially very quiet and not participating fully were now also making valuable comments and providing their input to the discussions and towards the research lesson.

In the second cycle of the LS the researcher noted the following in his researcher's journal:

Participants that were quiet were now participating more eagerly in the discussions and also giving input, suggestions and contributions. They were now showing more confidence than before.

The researcher further asked the following question to probe a bit further into the inclusion of the manager in the LS process:

R: In which way and to what extent did the manager in a participative capacity contribute towards building confidence in you and empower you through the lesson study process?

PL2: Uhm, the inclusion and involvement of the manager, it raised my confidence. I viewed the manager as a member of the team who was leading and supportive rather than the traditional 'I know it all' kind of approach that certain managers apply. It raises our confidence, it, we managed to talk and discuss on the same level as if the manager's presence was not there and there was no

differentiation between participants and the manager. His involvement gave me confidence.

Three of the four participants, that is 75%, mentioned that LS empowered them in terms of raising their confidence and becoming motivated through the process. One lecturer mentioned that he did not become more confident as he felt he is confident already and confident enough. This at least showed honesty on his part and came as a surprise. From the above it appears that most lecturers became empowered through LS as far as confidence and motivation are concerned. This concept was referred to roughly 20 times by the lecturers.

Furthermore, on the issue of confidence and motivation, the next participant noted the following in her participant's journal:

PL1: Lecturers are confident in their approach and everyone was contributing.

The following was observed in the researcher's journal on the issue of confidence and motivation:

Participants are more confident and focused and contributed in a valuable manner to the discussions as we are coming close to the cycle 1 and finalising research lesson 1.

Sub-theme 2: LS empowered lecturers to make decisions freely

One of the aspects of participative management is to give subordinates the power and ability to make decisions freely in a team and the LS process is a strong platform where decisions must be made and the ability for making decisions should not be stifled in any way. For participative management to be successful, there should be some form of a bottom-up approach which aids decision making. For the most part lecturers mentioned that they were free to make decisions and their decision-making skills improved, which was also empowering for them.

In connection with this, the researcher asked the following very important question related to the freedom to make decisions in the LS process:

R: In which way did the LS process in a team in the participative process of collaboration empower you to make decisions freely?

To this question the following lecturer, for example, mentioned:

PL3: Now I feel free to go to a colleague, in other words to be assisted. Yes. Yes, previously I didn't. There is also freedom to approach the manager. Free to go to other colleagues to share ideas; an open approach to working together.

He further mentioned how important it is for management to realise that subordinates also need to be free to make decisions in order to empower them:

PL3: The participative and collaborative approach in lesson study did not put you under a prescription or it wasn't prescriptive or restricted. I was free to be open in the process. I could also make decisions. It was flexible and I could actually come up with my own ideas and nobody said that's not a good idea. And managers should also learn that people also need to make decisions freely.

The following lecturer revealed that he was empowered because of the manager's involvement and, because decisions were made freely, agreements and consensus could be reached quickly. He said:

PL2: Ya, like I said, you (the researcher) were very professional in your approach and very nice and respectful. So, in that sense you empowered us. We ventured to express ourselves and you gave us freedom as well to express if anything was wrong, like we can just debate it. So that was a very mature approach.

The same lecturer further pointed out:

PL2: It empowered me to make decisions. Yeah, like I said, we discussed and we came to an agreement. There were no arguments, maybe more consensus on the things and to clarifying things. So that made it more for people to participate to bring challenging ideas and people showing respect for one another and for other people's knowledge and so on.

Another lecturer echoes what was mentioned before and put it this way:

PL1: Participation encourages free collective decision-making. Yeah, this relationship with my colleagues in any case (through the LS process) that I don't want to make the decisions by myself. I can still learn after all these years. I mean yah we know more we've been through the mills, but I mean we can still contribute something new and no one is going to shut it down because times change and things become modern and technological. So, decisions are freely made. Uhm, so now I don't feel that I was restricted actually like before. No, I would not say I was restricted myself and I could make decisions freely in the LS process and in participation.

The following lecturer has the same view. He stated:

PL4: OK, in the team I would say that we, the way it took place, it did empower us to make decisions freely which was restricted in a sense before.

All four participants mentioned that the LS process in the format in which it was done in this study, where the manager is present in a collaborative and participative manner, empowered them and empowered them to make decisions freely in the process and thereafter. Hence, it appears that the LS process is favourable in terms of encouraging members to make decisions freely. The issue of being able to make decisions freely was mentioned roughly 17 times by participants.

The researcher observed and noted the following in his researcher's journal about lecturers being free to make contributions:

Lecturers were enthusiastic and passionate about their field of study. They were eager and free to share their experience and knowledge.

The results above may be illustrated in a table as follows:

Table 5.4: Personal and professional improvement and empowerment

Personal and professional improvement and empowerment	
Sub-theme	**Frequency%**
Empowered to become confident and motivation increased	54%
Empowered to free decision making	46%

From the table above it appears that lecturers found LS to be a process which empowered lecturers to increase both their confidence and motivation. It was also a process which empowered lecturers to have freedom in decision making.

Theme 5: Managers' role in the use of LS and contributions managers can make to the LS process through their participation at TVET colleges

As mentioned before, at schools and at TVET college campuses, managers are seldom involved in lecturers' classes and lessons, except perhaps for the annual lecturers' appraisal. In many LS sessions, managers are also not fully involved in the entire process of the LS. Many LS cycles are run with the manager conducting a workshop on LS and an instruction to the group to conduct the LS by putting someone in charge. In this study the manager was involved throughout the entire LS process and his/her role of facilitator, guide and advisor among others became crucial. It was also revealed to be important elements to see the successful completion of the process.

This theme is divided into three sub-themes, namely improving the participative and collaborative culture at TVET colleges, guide and support and improved curriculum management.

Sub-theme 1: LS has the ability to improve the participative and collaborative culture at TVET colleges

Working together in a team of lecturers teaching the same subject and with a manager present has the potential to improve the participative and collaborative culture of an organisation such as a TVET college. This is possible if the lecturers in the team see

the manager as someone at the same level as the lecturer, and the manager is also prepared to be open and learn from lecturers individually and collectively, and implement that which he/she has learned through the LS process in all his/her management practices. It also has the potential to transform the organisation, in that, instead of instructions being top-down, it creates an atmosphere in which decisions and instructions can also be bottom-up since decisions are made in collaboration and in participation.

Lecturers were asked what role managers played in the LS process by posing the following question:

> *R: What role did the manager play in the LS sessions which you were a part of recently and what do think a manager's role should be in the LS process?*

Lecturers answered in various ways and different aspects were touched on. For example, the following lecturer mentioned that the manager shared the lecturer's experiences in the classroom and brought him to the same level as the lecturer. He mentioned:

> *PL4: In the LS situation we got to associate with each other on the same level and I think that was quite nice because it was informative also to have the manager present, to actually share experiences with the manager and I also realised that, although they are called the managers they actually do share and understand the experiences we have within the classroom.*

On this same aspect he continued and stated:

> *PL4: It was non-threatening, because normally a manager will come to your classroom for an appraisal, but here the manager was one of us, and I would say from a managerial point of view like, from their point of view, it was quite good to work with them on the same levels in participation and collaboratively.*

When the researcher further asked how the participation and collaboration in a team of lecturers and manager helped bring about camaraderie, the same lecturer said:

PL4: In the LS process I got to interact more with him (another lecturer) which I never did before and this brought about great camaraderie between lecturers teaching in different programs and this was a great new and positive development brought about by participating in the LS process and the collaboration.

On the bottom-up approach which LS affords, the following lecturer focused on the value of the bottom-up approach and mentioned that it was due to the participation and the collaboration aspects of LS which was never possible under normal circumstances. She pointed out:

PL1: I think people could just see you (researcher) as a colleague in that sense you are on the same level as all the others and we did not see you as a manager. In terms of LS, you have years of experience and you are worthy of leading the team. So, what managers can learn from this participation is that managers must not see themselves as managers in this process of LS. You are really on the same level and communicate with people (especially subordinates) more often because we don't always have time to do that because normally the manager instructs or we ask or request or whatever guide, filter down, cascade and you must also just sometime work together. LS teaches managers to have a more bottom-up rather than a top-down approach. I think we all appreciated it. I think so; we all felt like that.

With which the following lecturer agreed:

PL4: What's nice about the LS process is that the manager and us were on the same level and I think that also contributed with the confidence of the process and I would say it was a bottom-up approach for me that provided confidence because I could communicate on a level we do not get every day. For example, although my manager is like that, we can communicate on that level. The focus of students are different and for the manager to participate in the classroom through LS helps him/her not to become obsolete in his/her way of thinking because it's no use there are managers, but he is not in touch of what is happening in terms of technology, the classroom and the subject. This provides

him/her the opportunity to remain updated and get to terms of what is happening in the current time.

This lecturer also referred to the teamwork that comes about because of participation and collaboration. He mentioned:

PL3: So, it helped me to teamwork, it helped me to understand them (lecturers and managers) better and it also helped me to understand my students better and the lecturers (participants) better. Because that was because of the collaboration and participation.

He went on further by saying:

PL3: If you work with people, they might have a different way of doing things than what you have, but it doesn't mean yours is out of order, but if we collaborate and participate, we can make them interpret it better through the lesson study approach, the participative approach in a collaborative approach through lesson study. So now, if now we work together, we will know who's strong in what. So, the manager being part will also know who is strong and who is weak. So, and then to develop a structure and strategy of helping each other. So, if we do that through collaboration with working together, we can learn from each other. And the manager can take that and implement it.

Three of the four participants, that is 75%, mentioned the improvement of the participative and collaborative culture in various ways, such as the bottom-up approach of decision making, teamwork and camaraderie. Most of them were positive about the improvement of the participative and collaborative culture of TVET colleges. This aspect was mentioned 26 times by the participants.

The following was recorded in the participants' journals.

PL4: Session was enjoyable. Always a learning curve.

PL2: Very interactive. There was constructive engagement between lecturers and between lecturers and manager.

PL3: The collaboration was good and the purpose of the LS was reminded.

PL4: Planning collaboratively helps to understand ways to teach a specific concept.

The researcher noted the following in his researcher's journal:

The beautiful part of this collaboration and participation is everyone was very helpful to one another and participants were very willing to offer their part of bringing the lesson together. A real positive and open culture is developing.

Sub-theme 2: The managers' ability to contribute as a guide and support through their involvement, participation and collaboration in the LS process

It has been found through what lecturers revealed that the involvement and participation of managers in the LS process that they have the ability to contribute quite powerfully and positively by fulfilling their roles of being a guide as well as a support to the LS process. This has been shown to be the case in the LS process itself and has to be continued in all future instructional deliveries at colleges so that managers can become visible in classes in order to improve results. The following lecturers revealed that the manager's involvement has guided the process of LS and the presence and the visibility of the manager supported the process.

When the lecturers were asked,

R: Which ways can you suggest the LS process can be modified to include managers in a bigger way to make the LS process more effective and transform colleges?

The following lecturer answered:

PL1: As a manager, because then you most likely guide the process, think you need to build a good relationship with your staff. I mean if you are a manager of something that you know that you've taught yourself in that'll help you to guide the team, you know, that is, that is not easy.

The fact that the manager needs to be a guide who needs to be non-prescriptive and non-threatening, which was mentioned before was also mentioned by the same lecturer.

The manager is also there to keep the LS process on track which is something managers need to take note of. She further reiterated:

> *PL1: I think the manager's role is a guide who gives guidance and then also an observer, maybe a participant-observer when it is needed, when it is asked to give the group guidance, but not be prescriptive, but rather to observe and listen. Like I said before, I think definitely it's important to keep the people on track, to guide them to make sure that it's not done haphazardly and it is done thoroughly.*

The following lecturer mentioned that the role of the manager was to govern, organise, guide and support. He pointed out:

> *PL4: The involvement role and governing role of the manager is very important. He is the organiser, coordinator, guide and support. The manager was governing the whole LS process. The manager made sure that we were following what needed to be done within a specific time and I think that it was planned very well and prepared very well because we had the opportunity to edit and go back to the lesson plan within our weekly meetings which were organised by the manager (researcher).*

The following lecturers corroborated with the former one, but added that the manager also has a coordinating role and the manager participating with lecturers makes any enquiries immediate. For example, he mentioned:

> *PL3: Managers have a dual role. Firstly, managers should give guidance to the process in terms of structure around LS, overall must give structure to the process, which means manager must be informed about LS. Secondly, as an observer as well as giving input, not calling the shots but also learning from lecturers (participants) and what is taking place from his observations what the lecturers are saying (about content). He/she must also have the skill to pull it off and pull all of the elements together, which is a managerial skill; coordinator coordinating the process.*

With which the following lecturer agreed:

PL2: The first thing I can say is that the role of the manager is to build the quality of instruction through provision of curricular guidelines and curricular interpretations where necessary or where it is needed and where members need clarity, the manager will be there to assist and to use his/her experience to guide the educators immediately.

All four lecturers mentioned the role of the manager to guide, support and coordinate is important and came to the fore. It was mentioned 15 times by the participants.

The following was mentioned in the participants' journals by the participants:

PL1: The session was structured and to the point due to manager's guidance.

PL2: Facilitator (researcher and manager) handled group well and explained the research question and goal well. There was great buy-in from the LS group.

PL2: The manager's (researcher and facilitator) planning and direction was good.

PL3: The session went very well and all parties were certain of what was expected of them in the delivery of the lessons.

PL4: Each session better than the previous one.

Sub-theme 3: Through participation and collaboration LS can lead to improved curriculum management

Lecturers were also queried about the aspect of how LS can impact on the curriculum as the researcher wanted to ascertain how and to what extent the ideas and process of LS can be used to impact on and inform the curriculum and how managers can contribute in this process. The following question was therefore asked and many lecturers were positive that it can impact on the curriculum in a very positive way.

R: How and to what extent can LS impact and inform the curriculum and how can it assist managers and lecturers in looking differently at the curriculum?

For example, the following lecturer mentioned that because of the presence of the manager in the LS process, it is very practical. He mentioned for example that:

> *PL2: It will impact (the curriculum) and this is actually good because you have the grassroots people grappling with lesson content with curriculum and so on and then feeding into those people who set curriculum and so on, and make it more pragmatic or practical. Yeah, and saying like listen, this is our suggestion, take it or leave it, but this is it, we have now sat and collaborated in LS and we found this and that you know, these are the problems we are having because we also identified the problems related to it (through LS) and feed it through to the various people that are responsible (for curriculum).*

The same lecturer also highlighted how other managers, such as campus heads, beside ESs, can also become involved in feeding findings from LS processes into the curriculum by focusing on stumbling blocks with regard to the ML curriculum at their respective campuses. He mentioned:

> *PL2: This is like you say, we can always like look at the curriculum and also inform the campus heads and the problems that we are having from discussions. What are the stumbling blocks towards improving our standards at College? What are the stumbling blocks? Why are they not being able to do these lessons? So, they can look at a variety of things.*

The following lecturer mentioned that it is good that a manager is involved in the LS process as it is the responsibility of managers to implement the curriculum. This way the manager can see first-hand where the gaps are.

> *PL1: I would say like, for instance, curriculum is more a manager's forte for implementing the curriculum etc. but through the lesson study process especially now with space, shape and orientation, just focusing on it because that is what we have decided on. Yeah, I think it can, because the lesson study will be able to identify the gaps. Yeah. I mean maybe for the curriculum you must set time aside to address the gaps, before you deal with the more complicated issues. So, I*

think it definitely will influence the curriculum; yes unequivocally it will influence the curriculum in a positive way.

She went on further to make a very important point in that LS can play a large role to advise managers that an opportune time to discuss it (the curriculum) is at Focus Groups for the different subjects, in their annual review. She went on to say:

PL1: Maybe at focus groups we can say we have done this LS and the way it is in the curriculum or textbook it is not how it's supposed to be, because the students felt differently about it and stuff like that, and we think now it should maybe change to this or amend it to this way, keeping in mind that different classes respond differently to the same thing. But we must be careful not to water down the syllabus. So, I think it can and it will influence the curriculum if you are going to change your lessons at the lesson planning stage.

On the question of how the LS process can assist the managers and lecturers to look differently at the curriculum, the following lecturer said that the presence of the manager is important and had the following to say about it:

PL3: They (managers) don't consider on how we implement it (the curriculum). If we are with managers when implementing that curriculum, in the classroom situation will help them to, let's say, amend certain sections based on the outcomes that they see in the classroom situation or when we collaborate between lecturers and managers as we have done in the LS process.

The same lecturer also added the aspect of resources and mentioned that managers must also know what resources are needed and how a certain subject links with other subjects in the same program. He mentioned:

PL3: Because as it stands for now, this is the content, it must be delivered irrespective of, do you have the resources? Maybe you don't have or how will this link to a certain subject, like my students doing the policing, that is Safety and Society, so I am doing the maths lit, does it link with the subject Criminology? So how does it link? Yeah, I think those things will help managers (and lecturers) to look at the curriculum maybe differently when they are part of the LS process.

Since this study focused on misconceptions in the topic of space, shape and orientation in ML, the same lecturer further highlighted the fact that the gaps identified through LS in terms of the misconceptions should be used to amend and influence the curriculum. But he also added that it can only happen when the manager is involved and aware of it and it can only happen when there is a bottom-up approach. For example, he mentioned:

> *PL3: Whatever we find as a misconception that's what the curriculum needs to highlight because the focus, the emphasis of the curriculum must be based on what the students understand*. *Because some of the misconceptions may be based on the curriculum and because of the curriculum. So, it opens a gap and it widens a gap, but now the managers based in this lesson study can be able now to take in the form of a bottom-up approach, now to change the curriculum instead of a bureaucratic top-down approach.*

With regard to the curriculum, the following lecturer, owing to his participation in LS and his collaboration with lecturers and the manager, came to realise that the curriculum as it is can be very assuming, ignoring the social aspects and background of students and dictatorial in its implementation as he mentioned by echoing the previous lecturer's views:

> *PL4: From my experiences that the curriculum does not take into account the social context (background) of our students and for based on my experiences, the curriculum is a sense of dictatorship, we have to follow what the curriculum says and we have. There is no way we can leave certain things out or/and add something that is not part of the curriculum, so we have to follow the curriculum to the tee. If you look at curriculum, the assumption of pre-knowledge is there. It assumes that the student knows the pre-knowledge.*

The same lecturer added that the manager can play a big role in influencing the curriculum if he is involved with lecturers. He added:

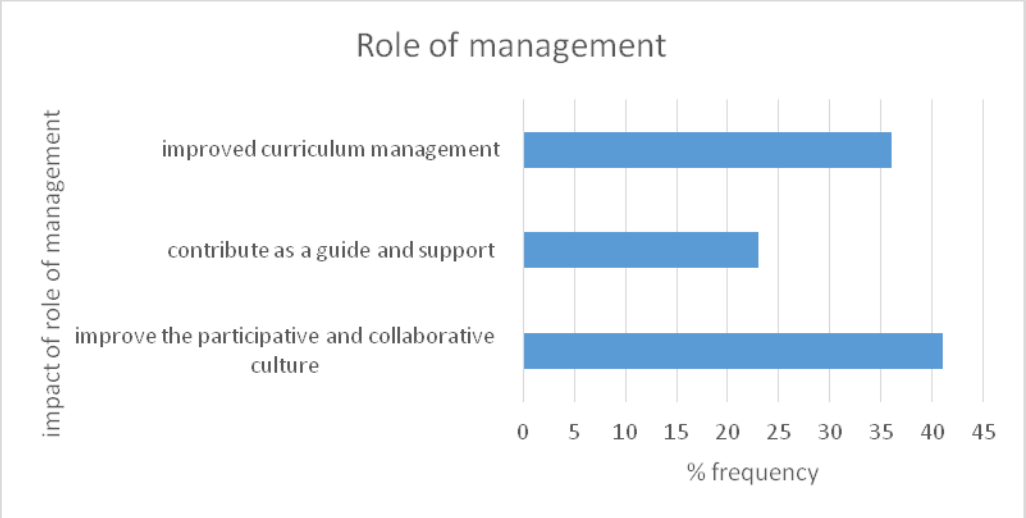
> *PL4: And from a management point of view, uhm, they can also through LS get the opportunity to see where the problems are within the curriculum and within*

the teaching and learning process and maybe they can also be involved in developing these exercises since they have the experience.

All four lecturers commented on the fact that LS can impact on the curriculum in a very powerful way and it appears that all the lecturers who commented on it felt very strongly that it can impact in a big way. This aspect of curriculum as a role for management was mentioned 23 times.

The results are illustrated in the following bar chart.

Figure 5.10: Chart showing aspects of the role of management in LS



The bar chart above shows that in this study the lecturers found the role of management in the LS process to bring about and improve the participative and collaborative culture at TVET colleges to be a greater benefit than the other aspects, such as the role of a guide and support and improved curriculum management, although the aspect of curriculum management also featured strongly as a role of management. Further interpretation and discussion on these aspects are done in chapter 6.

Theme 6: Challenges lecturers and managers are likely to encounter in conducting LS at TVET colleges

The process of LS is not without challenges. Some of the challenges revealed in this study were time, lack of resources, attitude and resistance from participants and managers' skills and knowledge. Time was one of the biggest challenges in most

literature cited in studies relating to LS and it was no different in this study. This theme was divided into five sub-themes, namely, time constraints, attitude and resistance, managers' skills, lack of resources and solutions to challenges.

Sub-theme 1: Time and time constraints as a major issue in LS

When lecturers were asked what the obstacles, negatives or challenges they encountered were and what managers need to be aware of during the LS process, most lecturers referred to time being the scarce commodity which is in short supply.

The researcher asked the following question to the participants:

> *R: What negatives and challenges were there for you, if any, in the experiences in the LS process and what must managers be aware of?*

For example, the following lecturers stated:

> *PL1: The only negative that I can think of is the time issue. It was very informative but in reality, we won't have I don't know how many hours? Seven hours to spend on a fifty-minute lesson, unfortunately. So, that's why maybe if we do one lesson at a time until maybe do a couple of lessons will take two or three lessons per trimester or per semester until over few years you've covered the whole syllabus on those areas that are giving problems.*

> *PL3: So, the issue was time, because we have deadlines. We have a lot of things to do. So, but we have to sacrifice and for the benefit of this because this is not about you but it's about implementing a strategy that will help everybody so we had to sacrifice the time, the usual time. No other negatives, I think everything was fine. That was the only thing for me, time constraints and meetings after class, yes that was tough for me.*

The following lecturer linked the issue of time to teaching and learning and specifically refers to the student-centred and problem-solving approach and he mentioned:

PL4: Uhm, I would not say there was anything negative necessarily, but if you look at the context, if I look at my own context in my classroom, sometimes time is a factor when it comes to a student-centred and problem-solving approach. The problem-solving approach depends on the student's ability to learn independently or in a peer relationship with his students. It does depend on the calibre of the students and our students are not ready for problem solving yet.

He went further by saying,

PL4: Timetable. LS in the college timetable, but make it voluntary, not forced. Furthermore, do not use admin period. For myself if it was timetabled, I would say it should not be timetabled like often, like maybe once a week like we have done it (in this study) and it should not be in place of a free/ admin period because lecturers might feel that is their time to do their admin, for example, because we have to acknowledge that this LS process and activity is an add-on to our current workload.

This same lecturer also mentioned that time can be a problem for managers:

PL4: Managers do also teach as well but for the major challenge I can mention already is time.

Another lecturer proceeded to say that we can start with the more challenging parts of the syllabus to save time:

PL1: To start maybe we can like look at space and shape like we have done now (in this LS) because it's always been a challenge but the finance and stats may be not as much.

As far as time is concerned, the following lecturer advised managers to set time aside purposefully for LS, otherwise it would be a waste when asked how she would implement LS at this college. She advised:

PL1: Oh, I think firstly is the time, putting the time aside, scheduling the time for that specific purpose. I mean you cannot just put time aside; it has to be for and with a purpose. It must be put down for this (LS) and it must be scheduled, it

must be structured. You know that you've got a goal that you need to work towards, and then sharing, I would say, within the college with like we said before with the departments and then maybe with other colleges. And I think that is where actually the manager will come in because you'll be the driver of the process.

The following lecturer also talked about time being a problem, but mentioned that it must be structured within the timetable. He noted that this is something that managers can improve on. For example, he pointed out:

PL2: Yeah. We spoke about that. Time can be a problem. If it is not structured within your timetable, it can be a problem. So, there must be time for that (LS). There should be like a specific time allocated for lesson study within in the timetable. I love that, so we can suggest like an hour for and it is your lesson study. Uhm, negatives? I don't see lots of negatives, I must tell you.

All the participants, that is 100% of the team, mentioned that time is a challenge for them and it appears that all the lecturers who commented on the issue of time being a challenge were in agreement that it was a challenge for them in one way or another. The issue of time was mentioned by the participants 10 times.

The issue of time was also highlighted in the participants' journals as follows:

PL1: Lecturers need to focus on exams and revision and preparation for the June exams. Their focus may be somewhere else. Time is an issue at this moment. Good input was provided, but we feel a bit rushed.

PL4: Time is of the essence.

The researcher also observed that time became a problem for the participants and noted the following in his researcher's journal at a time when lecturers were stressed in preparing for exams, audits, etc., which implies that managers need to plan correctly when it comes to LS.

Lecturers (team members) are experiencing challenges and feeling pressure from work stress. Energy levels are low and enthusiasm is low.

Sub-theme 2: Attitude and resistance from participants in the LS process

Resistance from participants can be a challenge before the LS starts and also during the LS process. Prior to the LS commencing, some participants may withdraw or some lecturers may leave for better pastures and this can disrupt plans such as happened in this study. At other times attitude and resistance may be a challenge during LS when lecturers have too much to do or are occupied somewhere else. In this study the main resistance was adjusting to the LS process and the program.

The following lecturer refers to the resistance managers might experience when conducting LS. It is related to the current culture prevalent at a college.

This lecturer was then further probed on this issue as follows:

R: In which way do you suggest resistance can be a challenge?

He explained:

PL3: The current culture how we do things will determine how much of an obstacle LS is. Timeframes, schedules of manager, etc.? In terms of how much admin lecturers and managers do, it might be caught with some resistance from participants in terms of how collaboration has to happen throughout. Might short-step it and not apply the full process.

On the same issue he further explained by saying that the collaboration was something new to him and he himself had to adjust. He mentioned:

PL3: The first obstacle was myself (laughs) because it took a bit of a paradigm shift and I had to get over how I think, how I process and analyse because we can benefit from collaboration, it's not only my way, it's all of our way. It's not only my space, somebody else is entering my space in the classroom, for instance. In fact, that was a big paradigm shift. We are sometimes our worst enemies,

because we don't want to change (resistance to change), we don't want to, plus it is not my lesson, it is our lesson. So, what managers must learn is that when we introduce LS to explain to all participants that they need to change their attitude or paradigm.

Although only two of the four participants, or 50%, mentioned attitude and resistance as a challenge in the LS process, it might go unreported. It appears that attitudes, such as resistance to the LS process, were not a major challenge in this study. It was only mentioned 5 times.

Sub-theme 3: Skills and knowledge of managers in the LS process

Some lecturers also referred to the skills of the manager involved in the LS process to be important to make LS a success. The following lecturer, for example, stated:

PL2: The person's approach to people, that could be problematic (if he has no people skills) and hence I say, if it was implemented you have to make sure that the managers, all managers, understand this. The negatives might be that, like we said, a bad manager. I don't mean bad (but not skilled). But a manager that is not knowledgeable about lesson study, education principles and so on. So, what the managers must learn is that when we introduce LS explain to all participants that they need to change their attitude or paradigm and put time-lines to it so that we can be more specific.

Only one participant from the four participant lecturers, that is 25%, referred to this aspect and it appears that skills and knowledge of managers when conducting LS process was not an issue with the three other lecturers. The issue of skills and knowledge of managers was mentioned 5 times by this lecturer.

Sub-theme 4: Lack of resources and training

Other challenges which can be a challenge at many TVET colleges are a lack of resources and training. This study has also revealed that both resources and training were in short supply. Another point which was highlighted by some lecturers is that if the

manager is involved in LS, the managers will be aware of it. For example, the following lecturers stated:

> *PL3: I think the resources, because we can't say, okay, this is what I have to show but I basically have, I'm not equipped on that, for instance, the issue of Geogebra. I'm not equipped with Geogebra (a software package used in mathematics and ML). So that can give managers an idea. Look, lecturers don't know Geogebra so managers must arrange for training for them.*

The same lecturer continued to put the emphasis on hard resources. He mentioned:

> *PL3: Because as much as I don't have a projector, which is I am not in control of the management side, for those space and shapes, because I might have a picture in mind, but there is no way the students can have the picture because they have a different picture in their mind, a different picture altogether. But if we display the picture to them it means now we are in the same boat. So, infrastructure and then now, material like in the case of mine. I can't even have the metre ruler like when I have to draw something now, I need to use my judgement, I am struggling with that side.*

The following lecturer shared the same view about resources with the previous lecturer and echoed the previous lecturer's words when he mentioned:

> *PL2: Check if there are enough resources for the lesson study. It's good that the manager is there facilitating because people can say, Yeah, but we don't have this. Why don't you see that we have this resource in the class, this is the problem, is what we are involved with.*

Only two of the four participants mentioned resources and training as far as LS is concerned. It appeared that the two participants were very vocal about it and is something that managers need to take note of for the smooth running of the LS process and beyond. The lack of resources was referred to 10 times by these lecturers.

Sub-theme 5: Suggestions to challenges for managers to be aware of in the implementation of LS

The following lecturer provided a solution as far as the lack of time is concerned, for lecturers to attend LS sessions or meetings, debriefing and lesson delivery. He mentioned:

> *PL4: A good idea is to have LS, but assistant lecturers can take the LS participants' classes and that idea makes sense because it won't add-on to the time of the lecturer. Classes can still go on and the students won't lose out and their time will also not be wasted.*

In connection with the above idea, the following lecturers also provided some solution to managers to make the entire LS process smoother with the use of technology and beyond LS. They added:

> *PL3: Uhm, in terms of time constraints, the solution could probably be to make use of the technology in terms of e-mailing and probably inventing some discussion forums while the LS process is going on. E-mails, text messages, some comments opening up commentary boxes and the like. I think that will greatly assist in solving part of the time constraints. Like it was by you (manager/ researcher).*

> *PL1: Create a forum of texting or e-mailing ideas to one another if there are any ideas participants have after the meeting, like a discussion forum something, we possibly missed etc. post-meeting discussion. Every participant must be on the same page as far as the research lesson is concerned. Google sheets can also be used for this.*

Three of the four lecturers, or 75%, felt the need to also provide some solutions to managers to the challenges they mentioned and were quite enthusiastic when the solutions were provided. It appears that they felt strongly about their solutions and for managers to look at when LS is implemented at the campus and the college of the

researcher. The need to provide solutions to challenges was mentioned 7 times by these participants.

The above information can be illustrated in a table as follows:

Table 5.5: Challenges of LS at TVET colleges

Challenges of LS at TVET colleges	
Sub-theme	**Frequency (%)**
Time constraints	27
Attitude and resistance of participants	13,5
Managers' skills and knowledge	13,5
Lack of resources	27
Solutions to challenges	19

From the table above it appears that time constraints and lack of resources are highlighted as challenges of the LS process more than the others, which was to be expected. Further interpretation and discussion on this aspect is done in chapter 6.

Theme 7: The future of LS in the TVET sector using the model of the LS-participative management

LS has the ability to focus our attention and reflection on many issues, ranging from focus on content to the role of management as well as to challenges and how these challenges can be addressed by lecturers but mostly by managers. It also improves the social interaction and empowers lecturers through increased confidence and motivation. Hence, there is definitely a future for LS at TVET colleges with the manager in a participative role as was revealed in this study.

Sub-theme 1: Participants as champions for LS at their colleges

Since the LS team in this study have experienced and acquired the skills of the LS process, many of them have indicated that it can be a great benefit for TVET colleges, provided that it is done in a gradual process, starting with campuses through the participants as champions accompanied by managers and escalating to colleges and then to the entire TVET sector.

When lecturers were asked how they would start their own teams implementing LS at their campuses for future LS, seeing that they have now successfully participated in it, some lecturers answered that they would first of all have to get managers involved by getting their buy-in.

In view of the statement above, lecturers were asked the following question:

> *R: Now that you were a part of LS, how would you start your own team implementing the LS process at TVET colleges and for your subject, and how will you get managers involved in the process?*

The following lecturer put it as follows:

> *PL3: Well, I think firstly is to approach the management side after considering the benefits which the colleagues (we) enjoyed in this lesson study and get other lecturers involved with a manager. So, I need the buy-in of the manager and it is basically to identify the benefits of that lesson study to the institution so that will be the highlight, the bottom line.*

The following question was further asked:

> *R: What suggestions would you make to managers to effectively implement LS at this college and the whole TVET sector?*

The following lecturers were all in agreement that they needed to get the managers' buy-in. They answered as follows:

PL4: I would start off with an information session, introducing the topic of LS to them (managers and lecturers) and explain to them the benefits of it. For example, the main benefit is having a group work a collaborative input. I would motivate it to managers by sharing my experience (from this LS), for example, getting to learn professional ideas of others and other than your own.

PL3: Well, one is basically to tell them when we work together, it's easy to overcome some challenges. Secondly, I need to tell that this subject (ML) is quite challenging, therefore I think some collaboration is needed. Well, I will suggest and recommend that like this kind of lesson study be implemented in our colleges, because it closes the gap between the managers and the lecturers.

PL4: I would say it will be better, rather to prepare a presentation and maybe take it to the line of management that is above them, and convince them, based on the benefits and the experiences of the participants and that the manager (researcher) may have in the LS process and, once having that confidence in the upper line of management, I feel it will be more powerful once it is studied on that level and then take it further to get management buy-in and once they have that management buy-in it will be easier to implement to the line of management below their own management, for example, as lecturers as managers of the students.

PL2: Look, I would say it should come first from, the buy-in must first be from the managers and the executive level from the managers of the college. That must be prominent; they must have the buy-in. If you're going to have one to start it now (without that) you are going to run into a lot of obstacles.

The same lecturer mentioned that having LS on campuses and at more colleges, students' results will improve in space, shape and orientation and overall, in ML. He further mentions that the value of LS should be seen. He mentioned:

PL2: There are, as with all new things, always you have difficulties like convincing people. It should be, I'll say structured in a way where it's accepted by all and the value should be seen, the value of it (LS), and nobody can dispute its

value because there is and it should be emphasised that this can raise your standard in your marks at your college. Similarly, the marks will also improve because students will understand better. That resources will be available because you look at what resources can be used.

The following lecturer supposed that even if you do not use the entire LS process, as it is time-consuming, elements of LS, or an adaptation of LS, can also be just as powerful. She mentioned:

PL1: So, basically what I am then saying is sometimes you cannot use the whole process of lesson study, but maybe you can take elements from that like observation, like you can maybe just one day come together and plan a lesson together on a certain topic that may be giving you problems or giving students problems and stuff. Yeah, and you can also ask the lecturers to come and be observers in your class and to sit with your students, then maybe you can be an observer in somebody else's class.

The following lecturers highlighted the seriousness of LS as a tool to improve ML at TVET colleges by suggesting that separate institutions should be started just for LS or a unit at TVET colleges dedicated only to LS. They stated:

PL2: Somebody must start a separate institution that just work on lesson study and do it for this college and then for all the TVET colleges like they are doing in other countries like Japan. You come in and say OK like we are going to look at LS and this is what we do.

He continued and commented:

PL2: Yeah, start like a special dedicated unit for LS that only looked at LS at a college and then transfer that knowledge to other people (TVET colleges) and invest in it (LS) plus maybe personal development and professional development, different methodologies and extra courses taking people out, so investing in the lecturers. And the main focus should be investing in the students. This lesson study is actually investing in the students. Investing in the lecturer also yes but this will ensure if you do, if your lessons are being done properly.

PL4: The LS process created the platform for us to converse with each other in an open and trustworthy way and I would say definitely that this should be a process that can be implemented within the TVET sector because, for me, I would say on an academic level, uhm, where they would say two heads are better than one and perfectly suits the function of LS. I would definitely recommend something like this to the TVET sector.

PL1: I would say, start LS within the college with, like we said before, with the departments and then maybe with other colleges and then the TVET sector.

PL3: Let's get a survey running of what topic would you think we should start with and in each subject, and timetable it and go… and then roll it out on a big scale. It has to start like that on a small scale in real context, not Japan's context, not USA context but for SA and then specifically for the TVET sector so that we can also have our data for TVET colleges. Schools, because it has so many districts and sectors, TVET colleges may be more successful in LS.

From the above comments and responses, it appears that all lecturers feel strongly about taking LS further at their own campuses for their subjects and others, as well for their own college as well as for the TVET sector. All of them felt strongly to become champions for LS at their own campuses and college. This aspect of LS was roughly referred to by participants 12 times.

The following was noted by the researcher in his researcher's journal with regard to LS being a benefit for the college and its future:

(When a senior manager was present – not invited to one of the LS meetings and overhearing the proceedings of the meeting which the researcher was conducting). The manager was blown away by the concept of LS and what benefits it can hold for TVET colleges, lecturers and students but also for managers like her. She further mentioned in an education specialist meeting the powerful tool LS holds for all NCV fundamental subjects and her referral to what the researcher is doing in ML and that all other education specialists are to attempt it in their subjects as well.

The following participant also made reference to the comments above in his interview with the researcher when he was asked what suggestions he would make to managers to effectively implement LS at this college and the whole TVET sector. He mentioned:

> *PL2: We had one of our senior managers (walking unannounced into the room where the meeting was held) and she was blown away. She was like, you know, like and she saw the value immediately. She's raving about it to everybody by the way, so, yeah, they (managers) will see the value of it, but also you must have people knowledgeable about lesson study to implement it.*

Sub-theme 2: The benefits of LS for the TVET sector

LS has huge benefits for the TVET sector in terms of collaborating and assisting the colleges to work together on issues of curriculum and other extracurricular matters. When LS starts at a college, through the various campuses, successes which are achieved can be exported to other colleges. This has huge benefits for students' performances, lecturers' abilities and transformation of the TVET college sector.

> *R: In your opinion what do you think will be the benefits in implementing lesson study in this format where the education specialist is a member of the team, throughout your college?*

The following lecturers stated:

> *PL3: Yes, there are many benefits, one is the teamwork; its basic core focus is the teamwork. And important for managers to encourage lecturers also to reflect on their lessons maybe in a collaborative way. I think that is one of the big benefits that that's a big benefit as well. So, I think the colleges can benefit, even the college sector as a whole can benefit in that sense.*

> *PL4: It is a benefit for TVET colleges because LS is different from the norm, meaning that the norm is the lecturer being inside lecturer in the classroom. So, I would say guaranteed that LS is a benefit for the entire TVET sector, because*

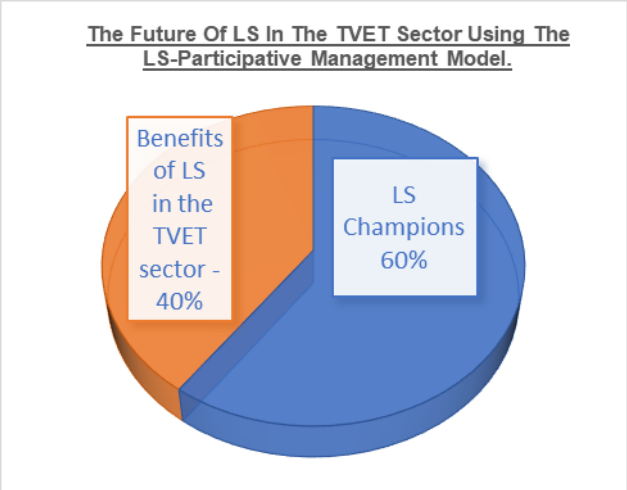
professionals of different ages get to share their experiences with each other across the TVET sector.

PL1: I wish we could do this more often and that this could be done across all programmes, subjects and levels. A good idea for future implementation.

Three of the four participants referred to the benefits of LS for the TVET sector and it appears that all three of them mentioned it very enthusiastically and positively. This aspect was mentioned by participants 8 times.

The results are illustrated by the following pie chart.

Figure 5.11: The future of LS in the TVET sector



From the pie chart above, it appears that lecturers would be very keen to become champions of LS at their TVET colleges first, before extending it to other TVET colleges in the TVET sector. It also shows from the chart above that there could be immense benefits for the TVET sector in implementing LS in this sector. A further interpretation and discussion of this aspect is done in chapter 6.

Theme 8: The need for the participation and involvement of management in LS

In this study the manager as researcher was part of every stage of the LS process and involved in all the LS stages, including all meetings and debriefings. Many lecturers in this section and previous sections have indicated advantages and benefits of having the

manager as part of the LS process. This has also been the foundation of the LS participative management model which the researcher proposed in this study.

Some participants mentioned quite strongly that LS should not take place without the managers' involvement. Some benefits for managers' involvement in LS which were revealed are: awareness what happens in the classroom, adding thoroughness, bringing structure to the process and improving relationships, camaraderie between manager and lecturer and the visibility of the manager is increased.

Sub-theme 1: Need of manager to be involved in LS

Lecturers were asked whether the manager should be part of the LS process by posing the following question:

> *R: So, what is your view in terms of whether a manager should be part of the LS process or not. Please explain.*

This lecturer answered as follows:

> *PL4: I would say definitely the manager should be part of the LS process and be involved in the LS process, I am not sure to what extent, but they should definitely be involved, maybe not fully involved but they should be made aware of the lessons that is taking place, the meetings that is taking place and maybe they can sit in the meetings as well to gain insight on what's happening because they have to know what is happening inside of the classrooms, and in fact I think they should actually be the ones to initiate the LS process if it is to be part of a college system. The fact that the manager was involved in the whole process I would say is a bonus and it should not be done without the managers' involvement.*

The following lecturers added that having the manager as part of the LS process brings about more thoroughness to the process.

> *PL1: I think it was done more thoroughly with the researcher (manager) being a part of it, because I think we're in that sense very similar to students. You know, the way you only do up until a certain point and then you stop, so I think with a*

researcher (manager) being present it's almost as if just analysing it more… and I don't think it would have necessarily been done that thoroughly without the manager.

She continued by saying that the presence of management in the LS process has brought structure and form to the process:

PL1: And the management is needed because, like I said, I think the driving force, people do need a push. Yes, as soon as you don't have anybody setting targets or submission date or deadlines or whatever, then there is no structure. And LS will fall flat. I think it is important for the manager to be present and visible, just to make sure that things happen, use the full time allocated for LS meetings and discussions. Visibility (of the manager) brings effectiveness to the process.

The following participant agreed and mentioned:

PL3: I will say it will help them (managers) to be part of any project that is being done. Okay, because they will know (what is happening) on our side of the story, and also great benefit to have the manager as part of the LS process. Better understanding of manager and can be approached. It changed my perception about manager. Relationship with manager improved dramatically. There are great benefits to have the manager on LS.

The following lecturer mentioned that the involvement of managers in LS brought about great camaraderie among managers and lecturers:

PL2: There was this great camaraderie between participants and manager which was good and this also resulted in participants respecting one another more. So, you learn to value people. You will also see, like my relationship with my fellow colleagues, also improved and with you (researcher and manager) also it improved.

The same lecturer mentioned that the manager should participate, but he can also delegate, but he must be present and also visible. He stated:

PL2: No, they (managers) should be there, should be part of it. But like I said they don't essentially have to take the lead all the time, they can just say, let's decide who's going to do the this process this time around, for instance, but must be there and visible and taking part. Yes, managers will have to be more visible and the relationship will improve and it has improved also, but like I said and I want to also emphasise that LS can't be introduced if there's no buy-in from the Campus Management.

All the participants, that is 100%, referred to the fact that a manager must be involved in the LS process and it appears that most of them were extremely favourable to it. The reasons ranged from the need for being aware of what transpires in the classroom of lecturers to increasing managers' visibility, bringing structure and thoroughness to the process and improving relationships between manager and lecturers. The aspect of managers' involvement was mentioned 26 times.

From a participant's journal the following was recorded by one of the participants:

PL2: Managers should follow this process of lesson study at colleges to see the benefits of this learning process – that is all managers, including and in particular, senior management.

Sub-theme 2: LS encourages a bottom-up approach when a manager is part of the LS process

The aspect of the bottom-up approach present in LS has already been mentioned in previous themes and it was also revealed under this sub-theme. The positive and open approach and the freedom to make decisions owing to the varied input which resulted from collaboration and participation, afforded members the opportunity to make decisions which are bottom-up rather than top-down. The bottom-up approach becomes even quicker if a manager is involved as part of the collaboration and is part of the decisions.

When lecturers were asked how and to what extent it helped for a manager to be part of the process instead of not being part of the process and team, the following lecturers stated:

PL1: LS teaches managers to have a more bottom -up rather than a top- down approach. I think we all appreciated it.

PL3: Be part of the delegation. So, I am saying for a manager to be part of the LS process is more a bottom-up approach than a top-down approach. They can learn that from LS, because LS is a participative thing

PL4: LS allows for a bottom-up approach to management as well. I would say it was a bottom-up approach for me that provided confidence because I could communicate on a level (same level with manager) where we do not get every day for example.

The following lecturer is of the opinion that most managers instruct a team on the strategy to be followed but are absent when it must be executed. Hence, he explains that*:*

PL2: Most managers are there for the strategy, but absent for the execution, so in LS the complete line is followed where the manager puts in the strategy, but is present to see and experience the execution (like in this study). Even as the observer, the manager as research leader diminished as that of an observer but the ability of the manager not to stay as the manager but come down to the level of a lecturer and become part of the whole process.

He further added that:

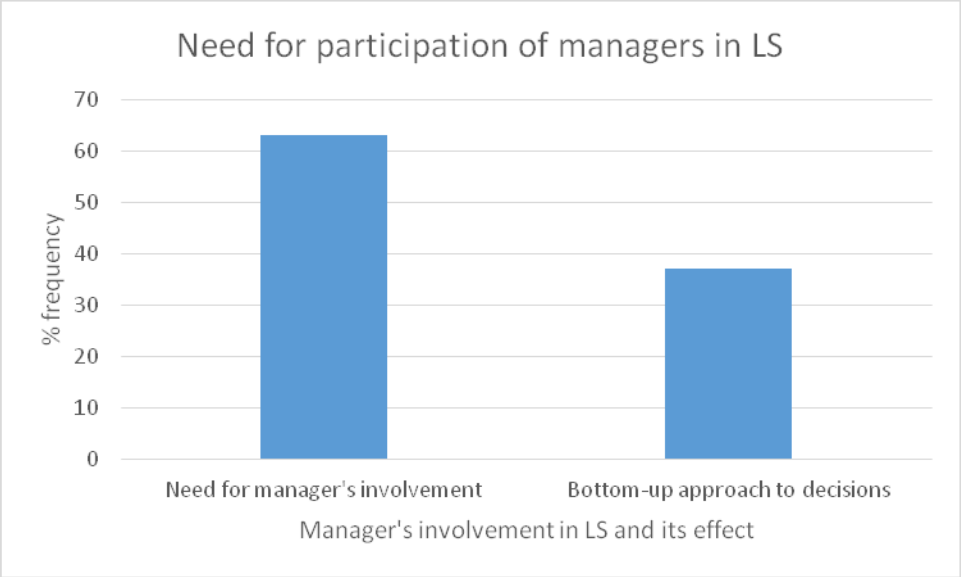
PL2: even though the intention of the manager is not to police in this process the presence of the manager in the process ups the ante because of the authority the manager has in the process. It entices an A-game, it encourages lecturers and participants to give of their best. It encourages that. It brings a level up because of the involvement of the managers in the process. For the managers to be involved in the process it becomes bottom-up and top- down. The visibility of the manager overall also improved the process.

All the four participants commented on the bottom-up approach of LS and when the manager is involved in the process and it appears that all felt very strongly about the

bottom-up approach to be the correct form of decision-making. The aspect of the bottom-up approach was mentioned 15 times in the interview.

The results are illustrated in the following bar graph:

Figure 5.12: Participation of managers in LS



From the above graph it appears that lecturers feel more strongly about the need for managers to be involved in LS and with lecturers in classes than the bottom-up approach in decision making, although the bottom-up approach in decision making also features in the LS process as an aspect managers should take cognisance of. The interpretation and discussion of the need for managers to be involved with lecturers is further discussed in chapter 6.

5.5 CONCLUSION

In this chapter the researcher reported the findings of a qualitative study which consisted of semi-structured interviews with four participants after a LS which consisted of two cycles. The researcher also reported on semi-structured interviews with five students (which included case students) after each of the two cycles. Furthermore, participants' journal notes as well as the researcher's own observations and field notes

were reported on to corroborate the interviewees' comments. The researcher's journal was documented after LS meetings and debriefing sessions.

The researcher analysed the data collected and organised the findings in eight themes and twenty-six sub-themes. The discussion of the themes and sub-themes are presented in chapter 6.

CHAPTER 6

DISCUSSIONS

6.1 INTRODUCTION

In the previous chapter the findings of this research were reported on by considering all the data sources that were used, namely participants' semi-structured interviews, students' interviews, the researcher's journal and field notes and participants' journal notes. Lecturers' observation sheets, students' answer sheets and brief meeting notes were also used. Eight themes were identified following a process of reduction from codes to categories and then further to themes. In this chapter the results are discussed by interpreting what was said and found and then giving meaning to it. The significance of the findings will also be discussed. This will be done by discussing the findings under each major theme.

6.2 DISCUSSION

The purpose of this research study was to answer the question of how managers can use LS as a management strategy to improve performance in space, shape and orientation in ML at TVET colleges. To meet this purpose of the research, the researcher sought to achieve the following objectives:

- To determine how managers can use lesson study in teaching space, shape and orientation at TVET colleges.
- To determine how managers perceive the use of lesson study in the teaching of space, shape and orientation.
- To determine what the managers' contributions are in lesson study when teaming up with lecturers in dealing with space, shape and orientation.
- To determine how the lesson study model may be modified to include managers in the lesson study team and the impact it has on the lesson study process.

The discussion is centred around eight major themes, namely a) Opportunity to improve lecturers' experience in the content knowledge of space, shape and orientation, (b) LS

provides lecturers and managers with reflection on instruction and instructional leadership, c) creation of an open organisational culture through collaboration and participation in LS leads to organisational effectiveness, d) personal and professional improvement and empowerment, e) managers' role in the use of LS and contributions which managers can make to the LS process through their participation at TVET colleges, f) challenges managers are likely to encounter (and solutions) in conducting LS at TVET colleges, g) the future of LS in the TVET sector using the model of management involvement, and h) the need for the participation and involvement of management in LS.

6.3 SUMMARY OF THE FINDINGS

The key findings of this research provided insights into the implications of the inclusion of a manager in the LS process and the LS participative-management model.

The first key aspect found in this study was related to student performance in terms of the lecturers' observation as far as space, shape and orientation were concerned. This may be divided into three broad categories: general misconceptions, areas they struggled with and lack of knowledge around the topic. For lecturers the most important aspect LS provided was the reflection it provided on the entire manner in which teaching and learning was conducted at TVET colleges in all stages of the LS process.

The second major aspect found was that LS is a powerful development tool to reflect on lecturers' instruction through their new found actions of coming out of isolation, the observation process of LS, focusing on observing students, student-centeredness and the anticipated student responses. It also found that LS provided for the creation of an open organisational culture through the collaboration and participation which resulted from healthy discussions through sharing ideas and knowledge among lecturers and the manager, encouraging openness, trust and respect and a non-threatening and positive atmosphere which ensued between the manager and lecturers.

Other key findings highlighted in this research study also showed that lecturers were empowered through personal and professional improvement which came about

because of increased confidence and motivation. This was as a result of the participative and collaborative aspect of LS as well as the inclusion of the manager in the LS process. In this respect, what was also interesting to find, was the fact that lecturers could make free decisions, even with the manager being present in the process. In fact, this study showed that with a manager present, free decisions were easier to make, clearly showing the effect of democratic decision making.

The greatest contribution that the manager could make was in terms of his role as a manager in the LS process as a guide and the support provided by the manager to lecturers in the process of LS. The inclusion of the manager in the LS process also enabled the participative and collaborative culture at TVET colleges to be strengthened, or where such a culture existed, it led to an improvement in the participative and collaborative culture.

An aspect which stands out in this study is that, because of the bottom-up approach, LS allows lecturers and managers to influence the curriculum when working together. Input which emanates from the collaboration of lecturers and through the inclusion of the manager can result in improved curriculum management. This study further found that the inclusion of the manager in the process led to immediate filtering of new ideas to be implemented.

As is consistent with previous literature (Ogegbo, Gaigher & Salagaram, 2019:6-7; Makara, 2016), this study also showed that LS did not come without challenges, such as time and time constraints, attitude and resistance by participants, lack of managers' skills and knowledge and lack of resources.

Findings which emerged as far as the future of LS at TVET colleges is concerned, showed that lecturers were eager to become champions of LS, first at their own campuses and colleges and then to transfer the related successes to other TVET colleges. Contrary to what was expected, it was interesting that lecturers insisted that managers must be involved. This fitted well with the LS participative management model proposed in this study. The study further found that any future endeavour involving LS at TVET colleges must have the buy-in of middle managers (such as education specialists) and senior managers. There was also agreement on the benefits

of LS for TVET colleges: that all TVET colleges would benefit if implemented there. Some of those benefits found were also consistent with what was found in previous literature.

Lastly, it emerged through this research that there is a pronounced need among lecturers to have the participation and involvement of the manager throughout the LS process. Lecturers who participated in this research also came to view the involvement of the manager as a means to encourage and promote the bottom-up approach.

The next few sections what was found is discussed, interpreted and explained in greater detail under each of the major themes and the corresponding sub-themes. The researcher also connects and links these findings with previous research and practices to ascertain similarities, differences and future implications.

6.4 THE LS PARTICIPATIVE MANAGEMENT MODEL, BRINGING TOGETHER ALL THE PIECES

This study indisputably shows that the interaction and the integration between the aspects involved in LS, coupled with PM and the involvement of the manager resulted in outcomes which can broadly be divided into teaching and learning outcomes, personal outcomes and managerial outcomes. These outcomes were clearly achieved, some by the lecturers, some by the manager and some by the students.

In this study, the outcomes revealed in teaching and learning at TVET colleges revolved around better teaching strategies (student-centeredness, problem solving, reflection and observation skills), a renewed focus on curriculum (a case could be made to amend it due to collaboration and participation and based on what was found through LS), and increased knowledge of content (through identifying students' and lecturers' understanding of content via identifying misconceptions and errors).

The interaction and integration of LS and PM involved with the manager in this collaboration have also revealed by bringing together the achievement of great personal outcomes such as personal and professional empowerment (increased confidence and motivation, non-prescriptive decision making), atmosphere of democratic decision making and a reflection of self.

Through the involvement of the manager and through PM, this study revealed that there was organisational improvement through cultivation of a positive atmosphere and supportive culture, improved curriculum management made more effective through the presence of the manager (manager's buy-in, bottom-up approach), overall better relationships and collegiality and potential improved networks throughout the TVET sector. This study also revealed that the manager's role should not be discounted as a guide, support and facilitator and his or her presence is crucial for this proposed model to work efficiently.

The researcher therefore makes the claim that to achieve all the above outcomes, the emergent model which he proposes is a sound model to be implemented at TVET colleges and to answer the research questions this study started out with. He further claims that LS together with PM involved with a manager is a powerful way LS can be implemented successfully by following this model.

6.5 INTERPRETATION AND EXPLANATION OF QUALITATIVE FINDINGS

Improvement in lecturers' experience in the content knowledge of space, shape and orientation in ML

LS provided a fantastic opportunity for lecturers, students and managers to engage and interact with the content of space, shape and orientation in ML in this study. Students interacted and engaged with the content through the challenges put to them via the student-centred approach and problem-solving approach. Through the challenge students faced, and the misconceptions, errors and mistakes made and highlighted, lecturers and the manager improved their experiences and gained a better understanding of students' shortcomings and their own shortcomings. This was due to working in participation and collaboratively with their peers and with the manager on interacting with the content especially, but not exclusively, through the stages of observation and debriefing of the LS process.

As far as students' performances were concerned, they may be divided into three broad categories as implicated in the results, namely general misconceptions, areas they struggled with and lack of knowledge around the topic. In the observation stages in this

study, lecturers identified misconceptions, errors and mistakes made by students that ranged from confusion with regard to formulae in the sense of thinking that there is one formula for all calculations in space, shape and orientation. Another error students made was the incorrect use and substitution of formulae. There was also the confusion about perimeter and area as well as misconceptions about what perimeter meant and confusion with identifying shapes. A surprising finding was that of adding shapes or lines inside a shape to the perimeter. As far as confusion between perimeter and area is concerned, this study is consistent with what was found in previous studies by Berenger (2010:27) in which the confusion between perimeter and area is also highlighted. There may be various reasons for this and one of the reasons could be that students find it difficult to identify shapes as was found by Utah Standards Academy (2014) especially where irregular shapes are involved.

Students' lack of knowledge of space, shape and orientation was also reported in this study and identified by lecturers through the observation of LS to be in the use of formulae, words, terminology, language and matching shapes to incorrect formulae. By far the biggest lack reported in this study was in the incorrect use of formulae. This is indicated in section 5.4 and Table 5.3.2; this was not surprising as this is consistent with research in the literature (Berenger, 2010; DCS perimeter, area and volume booklet, n.d.).

This study also showed what students struggled with, namely, calculating missing dimensions in an irregular shape, application of Pythagoras's theorem, decomposing a bigger area in an irregular shape into identified areas, and interpreting questions, especially how to answer questions. What this study also highlighted and was interesting to find was the fact that some students measured missing dimensions using a ruler. This is also indicated in section 5.4. Although this is somewhat consistent with Berenger (2010) in which it was found that students sometimes measure areas with a ruler, it differed slightly from this study which found that students measured missing dimensions with a ruler. It is important to note here the power of the observation stage of LS; this was observed by lecturers within the classroom as it was happening, which otherwise would not have been noticed by lecturers under normal traditional

circumstances. The power of the observation stage of LS also underscores the fact that LS is a form of action research.

Hence, what this study shows Mathematics and Mathematical Literacy lecturers and managers involved in these subjects, is the power of the observation stage of LS, in that, one would not easily identify misconceptions such as these in ordinary classes. This is so because lecturers are not always focused on what students are doing, for example, measuring with a ruler. Lecturers in class are also not focused on what students are talking about, for example, saying they have finished when they have not, and how they are behaving, for example, refusing to continue because they gave up. Furthermore, LS also provided a quick and effective way to identify errors and misconceptions as opposed to, for example, only identifying it through marking scripts. The debriefing session gives a quick avenue of discussing and strategising solutions for improved presentations of the research lessons to address these problems. This is possible because of the participative and collaborative approach of LS and also because the manager is involved.

In the student interviews held conducted the research lesson, it was surprising that this study also added that students themselves could confess what their misconceptions were. This implied that they themselves reflected on their own performance, did some self-reflection and learnt from this experience of LS by enhancing their experience and showing self-confidence by articulating strongly where problems are. This is indicated in section 5.4 under theme 1 and sub-theme 1 of chapter 5 where students' interviews are discussed.

Research has shown that, just as students need to learn continuously to improve themselves, similarly lecturers and managers need to engage in life-long learning in order to improve their knowledge in their subject (Delisio, 2008:3). This is consistent with what was found in this study as was reported on how the LS process improved their experiences and knowledge by engaging with the content of space, shape and orientation with their fellow participants during the LS process. This came about through sharing knowledge of content and participating with other professionals; reflecting on their own teaching and learning; and how to improve by engaging with other lecturers

and the challenges of students. This is conveyed by the results found in section 5.4 in theme 2 and sub-theme 2 of theme 1 of chapter 5.

In the study by Carrol (2013) it was found that LS highlighted the gap which exists between theory and practice by amplifying the knowledge of teachers to the anticipation of students' responses, developed confidence in their use of student-centred approaches, better cognitive questioning techniques and an open and honest reflection on their lessons, not to mention the enhanced collaboration skills developed. What was found in this study in terms of the gains and improvements in experience, included improvements in the questioning technique and the student-centred approach, moving away from spoon-feeding, including a more problem-based approach and a phased cognitive change in questions, for example, asking why and how, focusing on how questions are phrased and formulated with the student in mind and including more real-life examples. This view is also supported by Carrol (2013).

The findings in this section assist in answering the following research questions: *How can managers use lesson study in the teaching of space, shape and orientation at TVET colleges?; How do managers perceive the use of lesson study in teaching space, shape and orientation? and What are the managers' contributions in lesson study when teaming up with lecturers in handling space, shape and orientation?*

LS: Reflection on instruction

Participating in LS places great emphasis on the aspect of isolation of lecturers and specifically how LS removed lecturers from isolation which was an advantage for lecturers in this study. This study found that lecturers mostly do not come out of their lecture rooms and they seldom collaborate. Lecturers feel that other lecturers are too busy with their own programs and they very seldom take the initiative to consult managers or their fellow lecturers. Lecturers seldom sit together to discuss content issues with regard to their subjects, except perhaps at assessments and memo discussions and sometimes when content issues are discussed at Focus Group meetings for Mathematics and Mathematical Literacy. The idea of Focus Groups (FG) at TVET colleges in the Western Cape is explained in chapters 2 and 4.

Managers are also slow in developing programs for lecturers to collaborate or they are not aware of programs such as LS, for example. This study showed that novice lecturers or lecturers who have not taught ML as a subject for long, desire this collaboration and are willing to come out of isolation, provided programs are offered by management to do so. This corresponds with studies done by Coe, Carl and Frick (2010) in which it was found that LS brings teachers out of isolation by way of meaningful collaboration.

Managers are also not aware that some programs on their own isolate lecturers as reported in this study *'as far as my program is concerned, I am like in isolation because I'm working all alone'* and *'locked in my class alone and isolated'*. Although only two lecturers mentioned isolation, strong views were presented and this is the same with what Coe (2010) found.

Equally strong was the view that bringing lecturers out of isolation provided them with immediate consultation with other lecturers and their manager and beyond with regard to content, as reported in this study *'but now you get to them (managers) and other participants to help you with content'.* This view is shared in a study by McDonald (2009) in which it was found that content knowledge was increased among teacher participants and teacher practice changed in a positive manner, having a positive effect on students' learning outcomes.

Research as suggested by Berenger (2010) points out that we need to know what students continuously do incorrectly and why. According to Berenger (2010), we must know what students are thinking or were thinking when those mistakes were made and to find ways to identify those common misconceptions. In the LS process, this issue which Berenger (2010) raises, is powerfully addressed in the observation stage of LS. One of the interesting findings of this study and which has stood out very strongly, is the LS stage of observing students and specifically the observation of the selected case students. It has brought a totally new dimension to teaching and learning in the lecture rooms of the TVET college where this study took place. It has also put an important focus on instruction as well as an opportunity which allowed managers to observe it in action in lecture rooms of TVET colleges.

This is revealed by the fact that most participants viewed this stage of observation, an irreplaceable part of LS, as *'a novel idea'* and an '*eye-opener'* and a stage of the LS which they thoroughly enjoyed and want more of. *'I wish I could do more of that'* as they learnt about students' misconceptions in space, shape and orientation in ML.

What also emerged powerfully through this research was the fact that the observation stage focused lecturers' attention on the student which corresponds to the central idea of LS as putting the student under the spotlight. In this context, three lecturers noted the observation stage to be a form of alternative assessment and a high level of assessment, to focus on the remedial student and *'to put myself with the student and learn with them'.* This is indicated in section 5.4, sub-theme 2 of theme 2. Furthermore, it was also noteworthy that two lecturers exemplified the fact that the observation stage made them reflect on their own delivery by observing other lecturers delivering a lesson (the research lesson) and how they can improve on their own presentation in the future. This corresponds with a study by Burghess and Robinson (2010) which states that teachers learn best from and improve their practice by seeing other teachers teach. This happened in a very professional atmosphere and a professional sharing of knowledge among lecturers in terms of peer observation. It also allowed managers to adjust their perception towards the concept of lecturers' appraisals in future class observations.

Within a structure that facilitates the transmission, formation, reformation and reflection of lessons and instructional practices through collaboration (Marble, 2007:937; Hebe 2015) it was found that teachers' reflection on lessons can be very important to revise lessons in order to create revised lessons.

Another aspect which was highlighted rather strongly through the findings was the debriefing sessions after the delivery of the research lessons. This was taken seriously by lecturers in this study and it was viewed as something new and in a positive light as it was not usually done by lecturers when completing a lesson of their own. *'But we never reflect'* said one lecturer. Since it was reflected on by a group of people participating in collaboration with one another and by giving their view and input in the lesson, made it even more powerful. The debriefing sessions allowing for reflection on lessons

corresponds with studies conducted by Shúilleabháin (2015) as far LS providing lecturers with unique opportunities to observe students' activities in a co-constructed lesson for interpretation and reflection. This also assisted lecturers and the manager in terms of what could be changed and revised in future as far as the curriculum is concerned.

It was also found that doing the debriefing session as an optimal utilisation of time and a beneficial investment of time as reported in section 5.4 sub-theme 3 of theme 2, *'that will make more effective use of your time'.* This was also seen as a powerful professional development because after the debriefing and reflection stage, strategies could be immediately put in motion, unlike the traditional PD where there is no follow up. This is consistent with findings by McDonald (2009), Shúilleabháin (2015) and Coe, Carl and Frick (2010) which declare that the traditional professional development programs are no longer effective as there is no immediate implementation of what experts workshop people on. In fact, all the stages of the LS process in this study become a powerful way for PD.

It was also worthwhile to note that the debriefing session was seen as a sound encouragement for managers to encourage lecturers to always reflect on lessons in a collaborative way and for managers to become involved in classes. This is consistent with research by Jaca (2013) and Jita (2010) who are of the view that management must become involved with lecturers in their classrooms and thereby become more visible in the eyes of the students. This finding is important for managers as it shows that the involvement of managers in lecturers' classes could improve the performance of students in ML and improve the ability of lecturers to look at and reflect more deeply on their delivery and planning lessons in view of what was found in the debriefings.

With lecturers engaging in collaborative LS, their view of teaching also changed in as far as the delivery of lessons is concerned. Student-centred teaching and learning with a problem-solving approach took on a new meaning for certain lecturers. A strong element was the real engagement with fellow students, the involvement with the content, and the enjoyment and the inspiration it brought about. One lecturer also

referred to the fact that '*it places learning in the hands of the student'* as independent learning.

Student-centred learning and problem solving also brought about positive expressions from students as they enjoyed the teamwork that it afforded, as well as the engagement with fellow students and especially with the lecturer. This is consistent with research by Shúilleabháin (2015) and McDonald (2009) where student-centeredness and problem-solving approaches enhanced both lecturers' as well as students' performance. However, one lecturer did feel that students are not yet ready for the problem-solving approach at TVET colleges.

Another area which provided a great learning curve to participant lecturers in this study was the concept of the anticipated responses in the LS process in the different stages of designing the research lesson and throughout the LS process meetings. It helped lecturers to place the student uppermost in their minds when it came to planning a lesson. Lecturers started to think more deeply in terms of what they can expect students to do, what misconceptions can be expected and how to gear future lesson plans towards highlighting these areas. This aspect of LS placed a totally different angle to designing lesson plans to the extent of starting to think critically when designing lesson plans. This is also not something which lecturers paid a lot of attention to when designing lessons. All participant lecturers agreed that anticipated responses of students was a new and novel idea for them and something which they would use in their daily lesson planning going forward. This concurs with the studies by Carrol (2013) and Watanabe (2002) which showed that lecturers improved their knowledge and focus on students' anticipated responses as an inclusion when designing lessons.

In summary this study has shown that lecturers have not reflected or used many of the aspects referred to above in their planning of lessons. Many learnt other views on lesson planning such as anticipated student responses, debriefing a lesson and lesson observation.

The findings in this section will assist in answering the following research questions: *How can managers use lesson study in teaching space, shape and orientation at TVET*

colleges? and How do managers perceive the use of lesson study in teaching space, shape and orientation?

Organisational effectiveness through collaboration and participation in LS

Through working together as teams, these findings have revealed that all the aspects which make an organisation effective, such as healthy discussions, openness, trust and respect, positive relationships and sharing ideas were also experienced by the lecturers in this study. These aspects concur with Hallinger (2012), in that, where positive relationships in organisations prevail, organisations are said to be more effective. Hallinger (2012) further mentions that the promotion of a positive learning climate affects the organisational performance of an institution and its organisational culture. In this study LS showed that, through the collaboration and participation of lecturers, it has brought about a positive culture in the organisation and scored the highest interest.

Lecturers revealed that through healthy discussions, LS placed renewed focus on critical thinking and brought about discussions on content issues. What was interesting, was that lecturers have not only experienced this in the LS process, but they also experienced it after the LS process ended. Section 5.4, sub-theme 1 under theme 3 of chapter 5 reveals that '*this is now done more regularly and previously I only looked at my colleagues and never interacted and engaged with them in this way'.* Discussions about lessons and content do not usually take place since lecturers revealed that there is no time set aside for this.

It was worthwhile to note from this study that all lecturers stated how important sharing knowledge was between not only the participants, but also between them and the manager. This sharing assisted them in designing effective research lessons, sharing common experiences between them and the managers as well as being a benefit not only for this TVET college, but also for the entire TVET sector. Abdella (2015:54) also proposes a shared knowledge base that can be used by lecturers to share ideas, knowledge and skills and hence build a shared knowledge base which can be used by all; in this case, by all TVET colleges. In this study, sharing knowledge was achieved because the collaborative approach collectively brings together new ideas through the

input of experienced professionals, because when working together one learns from others which involves the concept of co-learning.

Furthermore, this study has also shown very strongly that sharing knowledge generally, and specifically as far as content is concerned, has brought about an open relationship among lecturers and between lecturers and the manager. See section 5.4 sub-theme 3 under theme 3 of chapter 5. This happened because the collaboration and participation provided an equal opportunity to share their experiences and their ideas in terms of content. This confirms research by Parker and Patton (2017) in which it is suggested that working together promotes learning as participation, social interaction through participative management and co-learning. The observation stage of LS in terms of being observed as well as observing others, achieved a great degree of reflection on themselves as well as a culture of openness and culture of improvement in lecturers in a very friendly way; fear of being observed disappeared. This openness led to a culture of friendliness, trustworthiness and interactive and constructive engagement which is also consistent with a study by Watanabe (2002).

As far as openness is concerned, what was also striking in this study was that the lecturers reported that the manager must also be open-minded, professional, engaging and non-restrictive in his approach for LS to work, which was the case in this study as most of the lecturers mentioned it in this study. This suggestion is also different to what is found in the literature and also an aspect which may be added from this research.

This study furthermore revealed that trust and respect are important ingredients in LS between lecturers and the manager and it played an important and essential role in every stage of the LS process. All participant lecturers felt it to be important. It is also true that for people to participate, especially where academic matters are discussed and debated, it has to be done in an atmosphere of trust and respect for one another. This is also in full agreement with Bell, Chan and Nel (2014:1970) and Friedman (2005) in which they found that collaborative participation often results in respect and trust between leaders and subordinates, positively improving confidence in staff and eventually in a positive organisational culture.

Research conducted by Rock (2017:3 & 5) shows that sharing the work with those who are actually doing the work produces more efficient and effective practices at the college level, which is nothing more than collegiality of working together in a team. It agrees with this study that participant lecturers also learnt to value their colleagues more because of the collegiality of working together as a team with different personalities towards the same goal. Camaraderie was displayed between lecturers and the manager by becoming closer to one another through co-learning, interaction and sharing ideas.

The findings in this section assist in answering the following research questions: *How do managers perceive the use of lesson study in teaching space, shape and orientation? and What are the managers' contributions in lesson study when teaming up with lecturers in dealing with space, shape and orientation?*

LS empowered lecturers personally and professionally

Participating with colleagues and collaborating with them towards achieving the same goals resulted in empowering lecturers personally and professionally owing to the fact that their confidence improved and this motivated them to improve themselves and improve their performance in class. This improved performance was then reflected by their students' improved performance in ML. This also concurs with the view of Wright (2009) in which it was found that teachers believed that their Mathematics content knowledge was positively affected in the areas of deeper understanding of students and themselves which led to an increase in self-confidence. This also corresponds with a study by Smith (2008) which found that the benefits uncovered were related to teachers improving their practice and gaining a sense of professionalism about their growth as educators.

There was an indication in this study that LS had an empowering effect on most of the lecturers; they also mentioned that as they gained more experience with LS, their confidence grew in trying out this new form of collaborative planning. They also gained confidence from working collaboratively with colleagues during the process. These are intriguing outcomes worth deeper examination and is consistent with studies done by

Carrol (2013) which found that collaboration resulted in confidence in various teaching approaches.

It was interesting to note that as far decision making was concerned, this study revealed that most lecturers pointed out that through participating in this LS, they became more empowered, confident and motivated. They became especially more empowered to make free decisions. Their confidence was boosted as they gained more professionalism and even the students' enthusiasm and self-esteem improved. This could be because students picked up the lecturer's enthusiasm which naturally rubbed off on the students as well. Evidence of this is displayed in sub-theme 1, of theme 4 in section 5.4 of chapter 5.

Lecturers were also more motivated and their confidence improved because they participated freely and everyone was able to provide input, irrespective of whether it was correct or incorrect. Hence, an atmosphere of democratic decision making was also experienced by participants and the manager. Furthermore, being part of this collaborative community gave rise to a motivation and interest to become part of a learning community or a community of practice which this study has also shown, since this building of knowledge did not just end when the LS process ended, but went beyond, as mentioned '*Even after the LS process I found it so easy to discuss content issues'* and *'this is now done more regularly'.* Hence, this study also agrees with the findings from Lee (2012:23-24) in which collaborative opportunities do not just build lecturers professionally, but that they also become part of a continuous learning community. For this to be successful, active collective engagement and collective participation is necessary by all participants in the process (Nash & Huffman, 2014).

Although this study was geared towards gauging the empowerment of lecturers, what was also surprising was that it was revealed through the students' interviews that students became empowered by their increasing confidence as they reported they are now less frightened to make mistakes, reported as, '*Make mistakes, sir, don't be frightened to make mistakes'* and '*Don't be afraid to ask for help'* a motivation to do better: '*Go over your work every day just for an hour or so'.* This is revealed in sub-theme 1, of theme 4 in section 5.4 of chapter 5.

What was very noteworthy in this study is that it revealed that lecturers not only noticed increased confidence in themselves, but they also noticed improvement in confidence in their fellow participant colleagues, especially those who were less confident at the commencement of the study, but later became quite motivated and confident as they started to give valuable input to the discussions. This was also clearly noticed by the researcher when he mentioned, '*Two of the participants who were initially very quiet and not participating fully were now also making valuable comments'* in sub-theme 1 of Theme 4 in section 5.4 of chapter 5. However, one participant lecturer mentioned that he did not experience any increase in confidence as he was already confident because of his many years in education.

Although the inclusion of a manager is mentioned in connection with studies regarding the increase, it brings in visibility and team work with lecturers as found in Hallinger (2012), Jita (2010) and Jaca (2013). Comments about the inclusion and involvement of the manager mentioned by lecturers themselves, was a great revelation in this study and different to what was anticipated. The inclusion of the manager was seen as a contributing factor towards raising confidence and motivation in this study as the participant lecturers mentioned that the presence of the manager in the LS process also raised their confidence as discussions between lecturers and the manager were conducted at the same level and because of the support the manager gave.

People become empowered when they are not restrained by too many restrictions placed on them and they are free to make important decisions without being prescriptive. This is especially true when these decisions had to do with classroom management, personal and professional improvement and related to academics such as content of subjects. This was also noticed rather strongly in this study as the participant lecturers mentioned that to make decisions was empowering for them and their decision-making powers improved; an open approach developed between fellow lecturers and the manager, and agreements and consensus could be quickly reached. This confirms the study by Gyasi (2015:2) that revealed that the headmaster's collaboration and jointly made decisions with the teachers through participative

leadership practice has the potential to develop and improve schools. This same model can be transferred to TVET colleges with the manager's collaboration.

The findings in this section will assist in answering the following research questions: *How do managers perceive the use of lesson study in teaching space, shape and orientation?, What are the managers' contributions to lesson study when teaming up with lecturers in dealing with space, shape and orientation? and How can the lesson study model be modified to include managers in the lesson study team and the impact it has on the lesson study process?*

Managers' role, contributions and participation in the use of LS at TVET colleges

As suggested by Jaca (2013), it has been shown that where managers are involved with lecturers on the ground and engaged with content, there is improvement in lecturers' content knowledge, instructional improvement and students' performance also improves because of the leading role that managers take with lecturers and the participation and collaboration. Vale et al. (2010:49) and Fick and Resnick (2001) also suggest that the manager must become a manager as learner and leader of learning. Consistent with this research, the presence of the manager in the LS process in this study immensely improved the participative and collaborative culture even further, firstly among the participant lecturers and the manager and then also further in the Mathematics department.

The participative and collaborative culture which occurred between participant lecturers and the manager was due to the culture of sharing the experiences lecturers had with the manager and vice versa and being at the same level and the non-threatening and non-judgmental attitude. Because of this non-threatening atmosphere, the act of bottom-up decision making became easier. This is consistent with research by Singh and Manser (2002) which suggests that to achieve a climate for effective participative management and transformational leadership, a non-threatening atmosphere and bottom-up decision making must prevail to create and maintain a participative and collaborative culture among lecturers and managers.

According to Bell, Chan and Nel (2014:1970), one way of influencing the organisational culture of an organisation is through the behaviour of its members. This study revealed that through the involvement of the manager in the LS process, his role became that of contributing as a guide and support, an increased focus on curriculum management and, through his involvement, improved the participative and collaborative culture at TVET colleges. Because of participative management being employed, collaboration improved, as was found by Danish et al. (2013:1341) and Makara (2016:23) that reminds us that the effects between knowledge sharing, participative management and transformational leadership on organisational performance lead to organisational effectiveness.

LS sets an important platform to investigate what role a manager can play in various ways in LS, but also a role which can be extended on a frequent basis as is consistent with research. LS taught managers that to be involved with lecturers in classes can really be a benefit. In this study it became apparent that the manager being part of the entire LS process resulted in sharing experiences with the manager by sharing the lecturer's classroom experiences. This does not always happen, and certainly not when the manager would have been absent in the LS process, as is usually the case when managers merely give instructions to conduct a LS process. This is consistent with suggestions made by Rock and Wilson (2005:89) and Jita (2010) suggesting that it is important to have someone serve as lesson study facilitator to guide the process, organise resources, and assist in finding coverage for classrooms to allow for teacher planning, observations and reflection/ critiquing sessions.

What was further interesting is that many lecturers mentioned that having the manager as part of the process brought both lecturer and manager to the same level and for the manager to be one of the lecturers. This was articulated as '*but here the manager was one of us'* and *'it was quite good to work with them on the same level in participation and collaboratively'* in section 5.4 under theme 5, sub-theme 1. It is here that the manager's role as a guide, support and facilitator, also became highlighted. This came out very strongly in this study owing to participation and collaboration because the boundaries of superiority and subordinate almost faded away by working together.

Appraisal is generally feared by lecturers, but participating in LS in this study also resulted in creating a non-threatening atmosphere with the manager being present. In connection with this, what also came out strongly in this study is the mention made that managers must learn not to see themselves as managers but at the same level as lecturers; this resulted in a more bottom-up rather than a top-down approach. This is somewhat different to what was found in the literature mentioned in this chapter.

In this study participants also shared their perceptions and experiences regarding the (manager's) researcher's function as the facilitator in the LS process. They reported that the researcher guided the process and ensured that participants received necessary materials and resources in a timely manner. This was reported both in the participants' interviews and the lecturers' journals. Many participant lecturers also reported that the participation and collaboration between participant lecturers and the manager quite strongly enhanced the manager's role of being a guide to give guidance and support in a non-prescriptive way and to keep the LS process on track. This statement agrees strongly with research by Watanabe (2002) which found that, although the lecturer is central in the LS process, the manager's role is important in terms of pushing the group forward and keeping them on track.

In this study it also became clear that to give this guidance and support to the LS team, the manager had to govern, coordinate, facilitate and apply his managerial skills. This is also mentioned in the study by Coe, Carl and Frick (2010) and Shúilleabháin (2015) on how important it is to provide continuous support by managers; it is vital for the success of the LS process, enhanced by participation and collaboration by lecturers and managers.

The fact that managers are involved in the LS process also makes any enquiries about the content immediate which fits very nicely into LS being work-embedded and classroom-embedded, giving support and voice to the action research aspect of LS as well, as agreed by Coe, Carl and Frick (2010:221-223) who mention that LS is contextualised within the classroom and it is an agent for change. This enhances the role of the manager when he is present and also collaborating and experiencing first-hand how the curriculum should be reviewed as this is what the DHET does from time

to time to be more appropriate for the labour market. The implication of this is that it will help if managers spend more time in lecturers' classes or lecture rooms and become more visible.

In view of the curriculum, this study reports that, through participation and collaboration, the manager can also assist in making a contribution to impacting and informing the curriculum as well as indicating where the gaps are. In fact, the LS process possibly provides a large platform to try out the implementation of a curriculum before making it official. This study shows that it is better to obtain first - hand knowledge of how a curriculum will play out by allowing people to grapple with it at grassroots and make it practical to feed it to persons higher up in terms of what works and what does not. Since the bottom-up approach of decision- making is at play, the way it can impact on a curriculum is easier when managers become involved.

All managers can become involved and the practicalities of the curriculum can be discussed at higher levels such as at Focus Group (FG) meetings. Managers also do not always see how a curriculum is implemented in class, so being involved in LS gives them this opportunity and can make this contribution to amend. To see how the curriculum works in the lecture rooms of TVET colleges is also a good way to highlight the theory-practice gap as proposed by Carrol (2013) which can be a powerful way to initiate changes to the curriculum. However, what this study has added to the literature is the involvement of the manager on the ground and the observation how the curriculum plays out as and when it happens in the form of action research and the immediate feedback managers can receive on curriculum aspects. Scrutinising the curriculum also gives managers the opportunity to look at resource shortages and how it links with other subjects and programs, which was also found in this study.

LS, through working in a team, has also brought about a renewed way of looking at the curriculum in terms of what worked and what did not by getting immediate job-embedded feedback, highlighting misconceptions, an opportunity to feed suggestions and stumbling blocks directly to seniors such as managers, senior managers and curriculum developers as it has been discussed by peers who are best suited on the ground. This also speaks to references made by Lucenario et al. (2016) in terms of the

class-embedded cyclical process LS entails, as well as the curriculum study and goals formulation, planning, conducting research and reflecting on the research lessons as a team-based action research.

Furthermore, the manager being involved with the LS team gets a direct account of how the curriculum is implemented on the ground in the classroom and any amendments needed as well as resources needed. How it relates to other programs can be escalated to higher levels by the manager. The dictatorship around the implementation also falls away to a certain extent.

The findings in this section assist in answering the following research questions: *What are the managers' contributions in lesson study when teaming up with lecturers in dealing with space, shape and orientation? and How can the lesson study model be modified to include managers in the lesson study team; what impact does it have on the lesson study process?*

Challenges lecturers and managers encountered in conducting LS at TVET colleges

Challenges which were encountered in this study were time constraints, attitude and resistance of participant lecturers, managers' skills, lack of resources and solutions to challenges. Just as with many other studies on LS such as by Ogegbo, Gaigher and Salagaram (2019:6-7), this study found that time seemed to be the greatest challenge and all participant lecturers referred to it as being a challenge and something they had to juggle with. What was surprising in this study was that lecturers also reported a lack of resources to be a challenge as much as time and time constraints.

In this study, as far as time was concerned, it was a challenge because lecturers' various other commitments and deadlines meant they had to juggle their time between classes, admin periods and examination preparation to be present at LS sessions. This also increased work stresses and pressures as was evident from what the participant lecturers revealed. This also meant many sacrifices had to be made by lecturers and managers; it also had timetable implications and impacted on other non-participating lecturers affected by the LS.

The issue of time was an issue in all the stages of the LS process and it had an effect on classroom time, planning time as well as in the lesson presentation, the meeting to debrief the research lessons as it consumed much time. This is consistent with what was found in previous research in terms of the time LS consumed and the challenges of time (Friedman, 2005; Makara, 2016; Ogegbo, Gaigher & Salagaram, 2019). This has implications for future planning of LS at TVET colleges and something managers must prepare going forward in terms of wise planning and scheduling and to improve on with LS at TVET colleges, especially in answering the question on how managers can use LS at TVET colleges.

Although only one lecturer mentioned attitude and resistance, it was really a surprise to learn about it in this study and something the researcher did not expect any lecturer to mention; rather something the researcher complained about. Although there are studies referring to participants' resistance and attitudes as far as LS is concerned, such as Makara (2016) and Smith (2008), this study added an issue which might go unnoticed and that is the resistance and attitude which lecturers themselves experience and feel, such as in this study that '*the first obstacle was myself (laughs) because it took a bit of a paradigm shift and I had to get over how I think'* as revealed in sub-theme 2 of theme 6 in section 5.4 of chapter 5*.* An interesting outcome of this is that managers must also take this also into consideration going forward with LS at TVET colleges. To some extent it also answers the first research question as to how managers can use LS at TVET colleges.

An inhibiting factor from management's perspective was the skills and knowledge of the manager. This also came as somewhat of a surprise and can be considered as an addition to this study over and above what was already cited previously. This further shows that the collaboration and participation encouraged participants to be open and speak their minds which relates to the non-judgmental attitude which was cultivated in this study through working together with the manager (researcher) in the team. Even though only one lecturer referred to it in this study, it does not mean it was not on other participants' minds. What this teaches managers is that, when working together with

your team on any project, it is important to take a people's approach, be knowledgeable about your subject and LS skills as well have good managerial skills.

This study further highlighted the challenge regarding lack of resources and a lack of training for lecturers at TVET colleges. This was highlighted because of the participation of lecturers in the LS process. This is a general challenge at many TVET colleges which includes not only physical resources for the particular subject, but also non-physical resources such as software packages and IT infrastructure to make teaching and learning more effective. This corresponds with research done by Makara (2015) and Abdella (2015) in terms of physical resources, but this study differs in terms of the reference made to resources of software packages, as previous literature the researcher referred to did not mention software packages. References were also made to the fact that when the manager is part of the team, he or she sees the lack of resources first -hand which can be immediately escalated to higher management.

Although challenges were highlighted in this study, some participant lecturers also proposed suggestions to managers on how they could provide solutions to these challenges. This was also unexpected and may serve as an addition through this research. Some suggestions for the time constraints that managers could contribute were getting assistant lecturers to take classes while the participant lecturers participate in LS, making use of technology by way of e-mails, discussion forums and Google sheets to keep the LS proceeding online when new ideas by participant lecturers and managers emerge. This technology platform can also be used by the manager to keep participants on track.

The findings in this section assist in answering the following research questions: *How can managers use lesson study in teaching space, shape and orientation at TVET colleges?; How do managers perceive the use of lesson study in teaching space, shape and orientation?; What are the managers' contributions in lesson study when teaming up with lecturers in dealing with space, shape and orientation and How can the lesson study model be modified to include managers in the lesson study team and the impact it has on the lesson study process?*

The future of LS in the TVET sector using the model of management involvement

There is definitely a great future for LS in education to improve not only performances in Mathematics and Mathematical Literacy, but also in other subjects as the literature has already shown. There can also be immense benefits for improving lecturers and managers in the process of LS and beyond. Going forward, this study has shown that LS has grown on participant lecturers, so much so that they are capable of becoming champions for LS at their own colleges and at other TVET colleges. This is advantageous for the TVET sector as a whole since it would have to be the lecturers together with managers who must eventually take this further and decide what issues to focus on and have the authority to decide on these practices as also posited by Watanabe (2002).

Furthermore, this study showed that participant lecturers reported that the approach they would take would include getting managers' buy-in in the LS process by getting both managers and lecturers involved and by showing them the benefits for the college, as well as for the lecturers, managers and students.

What stood out in this study is that most lecturers mentioned the importance of managers' buy-in in the process of LS without which it cannot work, which is also supported in the study by Goldshaft (2016) who refers to managers' buy-in. This must be done by explaining to managers the benefits of LS found in this study by participant lecturers, such as the input of the participation, collaboration and group work, sharing professional experiences and ideas, the ease with which challenges can be overcome working in collaboration and how this collaboration closes the gap between managers and lecturers. Further indications from this study were that for LS to be successful at TVET colleges in future, it is also important to convey the value it can add and how this can raise the standards at college in relation to students' performances and lecturers' presentations.

What also emerged as promising in this study, was the suggestion of some lecturers to set up LS institutions solely for the sake of LS purposes, thereby investing in students and lecturers by starting at the college in the different departments and subjects on a small scale and then branching to the TVET sector on a bigger scale. This idea was not

picked up in any of the literature the researcher came across and it may be an addition that this study can bring to the table.

Among the benefits participants mentioned that can assist the TVET sector through participation in LS, were teamwork, the collaborative reflection on lessons and sharing knowledge and ideas across the entire TVET sector.

The overall benefits revealed in the study may be summed up as follows:

- Students' misconceptions and errors can be highlighted;
- Sharing knowledge, expertise and camaraderie among lecturers and managers;
- Re-focused attention on lesson planning by reflecting and placing emphasis on students' anticipated responses;
- Reflection and follow-up were done within a classroom context and were job-embedded;
- Made students the central focus;
- Empowered lecturers through increased confidence and motivation;
- Focused managers' attention on shortcomings in the classroom and the TVET college'; and
- Created a positive and open school culture.

Some of the benefits above correspond with what was found in the literature by Stepanek et al. (2007), Esterhuyse (2015) and Kuromoto and Shi (2012).

The findings in this section help in answering the following research questions: *What are the managers' contributions in lesson study when teaming up with lecturers in dealing with space, shape and orientation?, How can the lesson study model be modified to include managers in the lesson study team? and What impact does it have on the lesson study process?*

The need for managers to be part of LS and the formulation of the participative LS model

In this study the manager as researcher was part of every stage of the LS process and was involved in all its stages. The advantages of having the manager involved and being part of the LS team have already been mentioned above.

In this study, lecturers mentioned that there is a need for the manager (as a researcher) to be involved in the LS process and this was mentioned very strongly by all participants. It was also mentioned by some participants that even if management is not fully involved, there must be some kind of management involvement. Most agreed that there should definitely be involvement and it cannot be done without the involvement of management even if some parts of it can be delegated, as some lecturers mentioned. It was found in this study that the involvement of the manager brought about thoroughness to the process, structure, manager's presence and visibility, change of perception of manager, improved relationships and camaraderie.

What was a surprising result from this study was that many lecturers reported that the involvement of the manager assisted in their freedom to make decisions, a result of the non-threatening and non-judgmental approach of the LS process. This is consistent with the participative management theory. Furthermore, this freedom to make decisions also resulted in a bottom-up approach to decision making which is quicker when it comes to reviewing the curriculum.

6.6 CONCLUSION

This chapter further discussed, explained and interpreted the findings presented in chapter 5 by first providing the key findings of this study, followed by discussing and interpreting the findings of every theme together with its sub-themes and comparing them with previous literature as to where they correspond, where agreement was found and where they differ. It also mentioned that what was found in this study could be added to the research.

In the next chapter the researcher outlines the conclusions of this study by answering the main research question, reflecting on the study, highlighting the limitations and making recommendations and suggesting ideas for further research.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 INTRODUCTION

This chapter presents (1) a summary of the findings, (2) recommendations, (3) limitations of this study, and (4) themes for further research.

7.2 FINDINGS AND CONCLUSIONS

The findings and conclusions on the main research question address how LS as a management strategy can improve the performance in space, shape and orientation in ML at TVET colleges. The answers to the sub-questions indicated in chapter 1, are presented in a structured discussion under the following headings: (1) managers' involvement with lecturers in the education process, (2) the personal and professional empowerment of lecturers, and (3) a renewed look at the role of management.

7.2.1 Managers' involvement with lecturers in the education process

The involvement of managers with lecturers happened first by improving the teaching and learning aspects of lecturers resulting in improved student performance. The results also indicated that there was a renewed focus on the content of ML, reflection, student-centred learning and problem solving together with students' anticipated responses.

The power of collaboration and participation was clearly revealed and was visible as participants wrestled with the content guided by the manager. Participants started to reflect on themselves and the education process as they picked up issues which otherwise would have gone unnoticed and they came to learn, know and apply the concept of anticipated students' responses on which the LS lesson plan is based.

7.2.2 The personal and professional empowerment of lecturers

Lecturers were also empowered with professional and personal aspects such as becoming more confident, motivated and coming out of isolation. This enhanced the positive and open culture at the TVET college through the collaboration and participation of lecturers and the manager as indicated by the participant lecturers.

The openness and positivity were enhanced by allowing participants to make free decisions and through bottom-up decision making that prevailed throughout the LS process.

7.2.3 A renewed look at the role of management

Furthermore, and very important, a renewed look was also placed on the manager's role as that of a guide, support and overall coordinator of the process of LS and the importance of these roles were even further highlighted as future roles of managers as participants in all aspects of education with their teams and the involvement of managers with lecturers.

Hence, the above-mentioned findings and conclusions structured under the headings mentioned in section 7.2, indicate that most of the research questions of (i) how managers can use LS, (ii) how managers realise the use of LS, (iii) what contributions managers can make in LS by teaming up with lecturers, and (iv) how the LS-participative management model can be used with the inclusion of managers, have all been answered to some extent.

7.3 CONTRIBUTIONS OF THIS RESEARCH

The following are noted as contributions that this study has made:

- The removal and disappearance of barriers that usually exist and perceived between lecturers and managers. Contrary to the belief that the presence of a manager brings tension and fear between managers and lecturers, this study has shown that an open and positive atmosphere had developed between lecturers and the manager. This has happened because of the involvement of the manager in the entire process of LS. It paved the way for more openness and positivity between managers and lecturers and showed that an improved open organisational culture can result and is possible through the empowerment of lecturers as it built more confidence and motivation. This was as a result of the free democratic decision making which the PM approach provided.

- Lecturers started realising that by reflecting on the manner in which they have approached the entire process of teaching and learning from lesson planning to the delivery of the lesson to debriefing and reflecting, needs to change and has changed as shown in this study and a paradigm shift must take effect. This was shown through the powerful new ways of observation, anticipation of students' responses, debriefing and reflection that were not previously taking place in classes or was not part of their reference framework.

- A model of LS incorporating PM and placing the manager as a pivotal role can have an effect on such aspects as teaching and learning outcomes, personal and professional outcomes and management outcomes - aspects that need to be investigated further.

- Through the LS stage of observation immense information can be gathered about students' misconceptions about space, shape and orientation of which this study has only touched the tip of the iceberg.

- The contribution this study can make to the action-oriented and immediate focus it places on the ML curriculum and the fact that it can influence the curriculum

positively through the bottom-up approach that LS through the collaboration with lecturers and the manager affords.

- The valuable and varied lessons managers learnt by being involved in the LS process, such as being a people-oriented manager, being an effective guide and support, sharing knowledge and expertise with lecturers and being a vehicle through LS to empower the lecturers.

7.4 THE LESSON STUDY MODEL PROPOSED IN THIS STUDY

The emergent model proposed in this study is the Participative LS model which, according to this study, was shown to be a sound model and should therefore be a model which can be proposed for TVET colleges hoping to achieve similar outcomes to those achieved in this study. It can most definitely also be proposed as a model where performance needs to improve in critical areas in other parts of Mathematics and ML as well as other subjects at TVET colleges where performances are poor and managers need to be involved. The critical part of this model is the involvement of the manager in the LS process and through participative management and collaboration of lecturers, the outcomes of this model can be achieved.

7.5 RECOMMENDATIONS

The researcher proposes the following recommendations:

- As done in the second cycle of this study (see appendix L), the observation sheet can be amended slightly to accommodate a column for every part of the activities which students are supposed to do and where the participant lecturer can make notes on his/her observations at every stage.

- Have a focus group interview with the participant lecturers instead of having individual interviews with participant lecturers. This will result in corroborating one another's experiences or openly disagreeing with one another's experiences as

well, and the collaboration that has already been established by the group will be enhanced and maintained.

- As was suggested by participant lecturers in this study, establish an institution for the sole purpose of the training of LS for TVET college lecturers and managers for implementing the LS process.
- Allow opportunities for participant lecturers who have gone through the LS process to become champions for their own college and then move forward to become champions for other TVET colleges in the TVET sector.
- Instead of conducting a study like this at one campus at one TVET college it would be advisable to conduct a study like this at more than one campus and TVET college simultaneously thereby increasing the impact of LS and hence increasing the sample.
- While virtual platforms for online learning and virtual platforms for meetings have been there for a long time, the COVID-19 global pandemic has fast-tracked them and has shown that they can be very successfully implemented now and in future. Implementing these platforms in some form and in some stages of LS can be very successful and can address the issues of time, distance and availability, and can work with more campuses and colleges. See the researcher's suggestions for further research below.

7.6 LIMITATIONS OF THE STUDY

Most research that is undertaken has some form of limitation that impacts on the study that one must be aware of. However, these limitations do not make the study a failure, but should rather serve as a means to see the study in the context of its limitations and acknowledge them. Although the current study had some useful research findings, it also had some limitations. The limitations that were identified during the conduct of this study can be summarised as follows:

The first limitation was the duration of this study. This study included two LS cycles and could possibly have given better results and more powerful experiences by participant lecturers if it included another cycle and thereby spanning an entire year. Better observations could have been captured by lecturers and a much deeper analysis could be obtained on misconceptions, errors, etc. Lecturers would have been more empowered and managers and lecturers would see the power of collaboration between them even more. A better result could also have been obtained in terms of the impact LS has on management as well as the organisational culture of a TVET college.

The second limitation is that this study was conducted at only one site or campus of a TVET college and hence one cannot generalise the findings for all TVET colleges and campuses and is therefore not a reflection of all TVET colleges. Furthermore, because of this the third limitation, was the fact that the sample was small as one could only use the number of Mathematical Literacy lecturers at that one site. In this particular study four participants who were the only four Mathematical Literacy lecturers at that campus were used. Had there been more, the researcher would have voluntarily used more. Hence, what was found could not be generalised for all lecturers.

A further limitation was the fact that only one level (Level 2) was used to investigate the research problem. Another level could have produced different results as those same misconceptions and errors might not have been misconceptions at a higher level.

The fifth limitation was that, since the topic chosen was space, shape and orientation, the study was planned in the time of the curriculum when the Level 2 students would be busy with it and the delivery of the research lesson and the revised lesson would fall in that time. However, it did not exactly work out in this way and it might have been out by roughly a week or so, which could have affected student's performance and hence the observation by lecturers.

A sixth limitation in this study was the fact that not all participants were present at all the LS meetings owing to other commitments. This could have given incomplete feedback and input towards the contributions of the findings. However, in this study, when there were participants absent for a LS session, there were never more than one participant

absent, and for both the research lessons and observations the full complement of participants was present.

The final limitation identified in this study was the subjectivity of the coding process as it is possible that different researchers could code the same data differently and could come up with different findings.

7.7 RECOMMENDATIONS FOR FURTHER RESEARCH

Recommendations for further research emanating from this current study are:

- The expansion of the model that emerged in this study, namely the LS PM management model, should be tested more thoroughly in the field. The field must include various colleges where the involvement of more managers at various colleges should be included. In this way the utility value of the LS approach can be tested.
- A further area of research could be to focus on one or two specific sections of the LS PM management model developed in this study and use that as an area of research. Any outcome listed in the proposed model in this study can be used as an area of research and examining how the manager's involvement can improve this specific outcome or what effect it has on this outcome by the involvement of managers.
- Areas of limitation mentioned in this study were duration and the sample of study. To address these limitations further research can be focused on a study including more than one campus at the same time, thereby also including more managers (education specialists) from every campus. This can easily be done because the curriculum is standardised and it can be conducted over a longer time such as a full year. This will also address the issue of a greater sample.
- Instead of space, shape and orientation another area in ML can be used with the same methodology followed in this study.

- Further research is also necessary to obtain experiences from managers who were involved in such LS processes. For example, a study may be conducted by a researcher using a manager or managers at different campuses or different colleges and the experiences which they obtain and find can be documented.
- Another idea for further research to this study could be to administer a pre-test prior to delivering the first research lesson and then administering a post-test to examine improvements in performance. This same procedure can be repeated for the revised research lesson to investigate any improvements in performance.
- Through the COVID-19 global pandemic it also highlighted further research on how certain aspects of LS can be incorporated virtually, especially certain meetings in LS.

7.8 CONCLUSION

This final chapter discussed the summary of findings, limitations, recommendations for further research, recommendations as a result of this study, and contributions of this research.

LS provides a promising strategy to effect a kind of change that would empower lecturers to create that change and for managers to drive the process by becoming involved with lecturers.

7.9 FINAL REFLECTIONS

This study presented the researcher with an opportunity to directly experience a teaching method at one of the campuses of a TVET college in South Africa. It made the researcher realise that LS is a powerful process that can and should be used at all education institutions to improve performances in subjects that are at risk. It also made the researcher realise that it is a process which can assist in changing a whole sector in a positive way.

This study presented the researcher as a manager with an opportunity to see the professional and personal development of four participant lecturers through the process of LS. It also presented to the researcher himself a valuable developmental experience through a period of roughly four years, an all-encompassing, holistic teaching method.

During this time the researcher gained new insights into Mathematical Literacy, lecturers' classroom practice, as well as the realities which these teachers have to face. It gave the researcher insights into the contributions that he should be making as a manager in improving ML at the college and it allowed him to reflect on his own management skills. The researcher also realised how important it is to be part of lecturers' rooms and be visible to students.

Lastly, this was a valuable four-year journey which involved a multi-disciplinary study consisting of Mathematics and Mathematical Literacy, aspects of education management, and a fairly new teaching method in South Africa, called lesson study. The researcher learnt and experienced an immense amount, by doing literature reviews, studying the underlying theories in education and management, and conducting the research on LS itself.

We as lecturers and managers do not cover half of the aspects that are required by LS at education institutions and my wish through this study is for it to take root at education institutions, especially at TVET colleges, to not only improve the performance of students and lecturers, but also the performance of the managers of these programs.

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APPENDIX A: REQUESTING PERMISSION TO CONDUCT RESEARCH

Request for permission to conduct research at a TVET College

Title of the research: Lesson study as a management strategy to improve performance in space, shape and orientation in Mathematical Literacy at a Technical and Vocational Education and Training College.

Date: September 2018

Dear CEO

I, Shaik Mohammad Hassan, am doing research under supervision of Professor Jojo, a professor in the Department of Mathematics, towards a DEd at the University of South Africa.

The aim of the study is to look for ways to improve the overall performance of Mathematics/Mathematical Literacy by focusing on space, shape and orientation and to identify misconceptions through the use of lesson study as a management strategy at TVET colleges.

Your college was selected for the convenience and the ease of setting up meetings as well as working with the existing timetables and easy access to managers, lecturers and students.

The study will entail the selection of a lesson study team at one of your campuses, consisting of the researcher as participant observer and three Mathematical Literacy lecturers. A lecturer will select a class group after which a topic section or sub-topic of space, shape and orientation with which students struggle with. The lesson study team will then create a lesson plan collaboratively on that section of the work. The lesson will then be delivered by a selected lecturer while the other lecturers in the team observe case students whom the class lecturer had identified. The rest of the students will also be observed but more emphasis will be placed on the case students. How the student behaves, performs, discusses and thinks at different stages of the lesson will be observed, documented and compared to expected and anticipated behaviours. Throughout it all the researcher as a participant observer will observe the entire process, give advice and direct the process and carefully note how misconceptions are identified and in what manner managers can become more visible in the process.

Immediately after the delivery of the first lesson (which is called a research lesson) the team will meet and a debriefing session will take place and the observations, especially of the case students will be shared and any deviations from the expected and anticipated behaviors will be

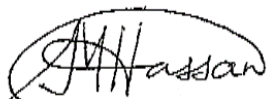
documented and a new revised lesson will be designed. This revised lesson will then be delivered by a different member of the team and the cycle will be repeated with another group of students. Semi –structured interviews will be held with the lecturers and case students after each cycle and observation by the researcher will also be documented. The interviews will be recorded and transcribed verbatim.

The benefits of this study are improved performance in Mathematical Literacy through improved performance in space, shape and orientation as well as the identification of misconceptions in space, shape and orientation which are encountered. It will also benefit lecturers in designing lessons with the student in mind and in terms of how students learn. It will also benefit education specialists, program heads and campus managers to be more involved with lecturers and students as well as to encourage managers to use the process of lesson study in all other subjects at TVET colleges.

There will be no risk to the participants of the study, namely the students or lecturers. Consent to conduct the research with the participants will be sought beforehand and in case of students under the age of 18 the parents' consent will also be sought.

There will be no reimbursement or any incentives for participation in the research.
Feedback procedure will entail giving a short talk to students and lecturers on the findings of the study.

Yours sincerely



Shaik Mohammad Hassan

Education Specialist for Mathematics and Mathematical Literacy

APPENDIX B: APPROVAL TO CONDUCT RESEARCH AT A TVET COLLEGE

September 2018

Dear Mr Hassan

Your request to conduct research at our TVET college is approved. Please note that we would like a copy of your research paper when you have concluded your studies.

Kind regards

CEO

APPENDIX C: REQUESTING PERMISSION FROM PROSPECTIVE PARTICIPANT (LECTURER) IN RESEARCH

Date: 6 March 2019

Title: ***Lesson study as a management strategy to improve performance in space, shape and orientation in Mathematical Literacy at a Technical and Vocational Education and Training College.***

DEAR PROSPECTIVE PARTICIPANT

My name is Shaik Mohammad Hassan and I am conducting research under the supervision of Professor Jojo, a professor in the Department of Mathematics, towards a DEd at the University of South Africa. We are inviting you to participate in a study entitled:

Lesson study as a management strategy to improve performance in the topic space, shape and orientation in Mathematical Literacy at a Technical and Vocational Education and Training college.

WHAT IS THE PURPOSE OF THE STUDY?

This study is expected to collect important information that could assist lecturers at TVET colleges to improve their delivery in Mathematical Literacy by becoming aware of and also be able to identify misconceptions around space, shape and orientation by learning the skills of observation as used in the lesson study process. Lecturers will also be able to design powerful lesson plans taking cognisance of these misconceptions. The study will also collect information on how lesson study can be used by managers and management to improve the instructional leadership towards the teaching and learning of Mathematical Literacy.

WHY AM I BEING INVITED TO PARTICIPATE?

You are invited to be a special part of my study because of your experience and knowledge of Mathematical Literacy as well as your willingness to try out new methods of delivery. The convenience of working with you at the same college as a curriculum advisor and coordinator of Mathematical Literacy is an added advantage.

The number of participants in this proposed study includes you and another three lecturers at the same campus. Hence, the number of participants will consist of four members in this lesson study group. A research lesson developed and designed by the three members of the lesson study team will be delivered to a group of students which will not exceed 30 students and the focus of observation will be on case students not exceeding 2 per participant. The number of participants who will be interviewed will be the three lesson team members and the 8 case students.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY?

The study involves the lesson study team working in a team (where you will be one of the team members) to design a lesson plan collaboratively with the other team members on a certain section of the work in space, shape and orientation which students struggle with. You will also deliver a lesson to a group of students in an actual lesson, observe case students, and make notes on what you observe, be part of a de-briefing session and design a revised lesson. After a session you will answer questions in a semi-structured interview on your experiences you gathered and gained from this lesson study cycle. All the interviews and debriefing sessions will be digitally recorded and will be transcribed verbatim.

The expected duration of the actual two cycles of the lesson study process in terms of data collection will be roughly 3 months commencing in February 2019 and the duration (approximate as it could be less) of each session of a cycle can be broken down as follows:

Session 1: Maximum of one hour, explanation of the lesson study process to the team members by researcher.
Session 2: Maximum of one hour, deciding collaboratively on the goal and designing a lesson plan together
Session 3: Maximum of one hour, bringing together the research lesson
Session 4: Maximum of 50 minutes, delivering the research lesson to a group of Level 2 students. To be done and scheduled as part of the existing timetable so that it is not scheduled outside the existing timetable.
Session 5: Maximum of one hour, debriefing session on what was observed.
Session 6: Maximum of one hour, interview with lecturers
Session 7: Maximum of one hour, interview with student's lecturers not involved.

Session 8: Maximum of one hour, re-design the lesson collaboratively.
Session 9: Maximum of one hour, deliver the lesson to a different group of students by a different member and observe a new set of case students.
Session 10: Maximum of one hour debriefing session
Session 11: Maximum of one hour, interview lecturers
Session 12: Maximum of one hour, interview case students.

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time and without giving a reason.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

The potential benefits of this current study are varied and numerous and it ranges from individual, group, college and subject. The individual lecturer will benefit from participating in this study because it will improve not only the design of the lecturer's future lessons, but also his/her delivery of lessons. Over and above that the lecturer will become a powerful observer in class and will be able to gear his lessons taking cognizance of these observations and misconceptions. The lecturer will also learn to work cooperatively in a team and learn team dynamics and thereby also be part of continuous professional development.

The campus and the college will benefit as well through the lecturer being part of the lesson study process. The ideas of lesson study can and may also be extended to other subjects and disciplines which can be a benefit for the entire college community. Finally, Mathematical Literacy will benefit in that the lecturer making direct input into the curriculum.

ARE THERE ANY NEGATIVE CONSEQUENCES FOR ME IF I PARTICIPATE IN THIS RESEARCH PROJECT?

No potential discomfort, injury, harm or inconvenience is foreseen for the participant taking part in this study, physically, emotionally, academically or otherwise. The only inconvenience is one or two hours per week meeting time until the cycle is complete.

WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

You have the right to insist that your name will not be recorded anywhere and that no one, apart from the researcher and identified members of the research team, will know about your involvement in this research. Your name will not be recorded anywhere and no one will be able to connect you to the answers you give. Your answers will be given a code number or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings

Only the researcher will have access to the data and the researcher is the only one who will work with the data as far as transcribing is concerned. Utmost care will be taken to maintain confidentiality.

Please note that your data may be used in a research report, journal articles or conferences but it will be kept anonymous and confidential. No individual participants will be identified in any such reports.

HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?

Hard copies of your answers will be stored by the researcher for a period of five years in a locked filing cabinet at his house. For future research or academic purposes, electronic information will be stored on a password protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. After five years hard copies will be shredded and electronic information will be permanently deleted from researchers' computer.

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?

The participant will receive no payment or incentives for participating in this research. However, the researcher is prepared to deliver a lesson or two for time lost, if any.

HAS THE STUDY RECEIVED ETHICS APPROVAL?

This study has received written approval from the Research Ethics Review Committee of Unisa. A copy of the approval letter can be obtained from the researcher if you so wish.

HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?

If you would like to be informed of the final research findings, please contact Shaik Mohammad Hassan at 073 105 1858/021 762 1230 or by e-mail: Mohammad.hassan41@yahoo.com/mohammad.hassan@falsebay.org.za. The findings are accessible for 5 years.

Should you require any further information or want to contact the researcher about any aspect of this study, please contact Shaik Mohammad Hassan.

Should you have concerns about the way in which the research has been conducted, you may contact Prof ZMM Jojo, Department of Mathematics Education, College of Education, 7-17 AJH Building, Unisa. Tel: 012 429 6627 Mobile: 073 488 2211 e-mail: jojozmm@unisa.ac.za

Thank you for taking time to read this information sheet and for participating in this study.
Yours sincerely

_____

Shaik Mohammad Hassan

CONSENT

I have read and I understand the provided information and had the opportunity to ask questions. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and without cost. I understand that I will be given a copy of this consent form. I voluntarily agree to take part in this study.

Participant's signature _____ Date _____

Researcher's signature _____ Date _____

APPENDIX D: REQUESTING PERMISSION FROM STUDENTS IN A TVET COLLEGE TO PARTICIPATE IN A RESEARCH

Title of my research:

Lesson study as a management strategy to improve performance in space, shape and orientation in Mathematical Literacy at Technical and Vocational Education and Training colleges.

Dear Student Date: 9 May 2019

I, Shaik Mohammad Hassan, am doing research on Lesson Study as part of my studies at the University of South Africa. Your principal has given me permission to conduct this study at your college. I would like to invite you to be a very special part of my study. I am doing this study so that I can find ways that your lecturers can use to improve their teaching and hence improve students' learning and performance in Mathematical Literacy. This may help you and many other students of your age in different TVET colleges in Mathematical Literacy.

This letter is to explain to you what I would like you to do. There may be some words you do not know in this letter. You may ask me or any other adult to explain any of these words that you do not know or understand. You may take a copy of this letter home to think about my invitation and talk to your parents about this before you decide if you want to be in this study.

I would like to ask you to be part of a group of students within a normal classroom situation and period who will be observed during the delivery of a lesson on the topic space, shape and orientation. The lesson will be delivered by your own lecturer or another mathematical lecturer and you will be observed by all the lecturers present. For this study there will be only four lecturers present in the classroom. I would also ask you to answer some simple questions after the delivery of the lesson.

I will write a report on the study but I will not use your name in the report or say anything that will let other people know who you are. Participation is voluntary and you do not have to be part of this study if you don't want to take part. If you choose to be in the study, you may stop taking part at any time without penalty. You may tell me if you do not wish to answer any of my questions. No one will blame or criticise you. When I have completed my study, I shall give a short talk about some of the helpful and interesting things I discovered in my study. I shall invite you to come and listen to my talk.

The benefits of this study are improved performance overall in Mathematical Literacy through a better understanding of the topic space, shape and orientation brought about through the process of lesson study. You will also have the benefit of different lecturers delivering to you which may improve and expand your understanding of the work as well as having individual attention given to you through their improved active observations in the context of the classroom.

There are absolutely no potential risks to you involved in this academically, physically or otherwise since whatever section and time you will be involved with will not involve a disruption to the existing timetable and hence no time will be lost from actual work. There will also not be any extra periods of Mathematical Literacy which you need to attend. However, interviews that will be held with you can be facilitated and arranged during college time only.

You will not be reimbursed or receive any incentives for your participation in the research.

If you decide to be part of my study, you will be asked to sign the form on the next page. If you have any other questions about this study, you can talk to me or you can have your parent or another adult call me at the number below. Do not sign the form until you have all your questions answered and understand what I would like you to do.

Do not sign the written assent form if you have any questions. Ask your questions first and ensure that someone answers those questions.

Researcher: Mohammad Hassan

Phone number: 021 7888373 w, 073 105 1858 c

WRITTEN PERMISSION

I have read this letter which invites me to be part of a study at my college. I understand the information about the study and I know what I am asked to do. I am willing to participate in the study.

Learner's name (print):	Learner's signature:	Date:
Witness's name (print)	Witness's signature	Date:
Researcher's name (print)	Researcher's signature:	Date:

APPENDIX E: REQUESTING PERMISSION FROM PARENTS FOR THE PARTICIPATION OF STUDENTS UNDER THE AGE OF 18 (MINORS) TO PARTICIPATE IN A RESEARCH STUDY

Dear Parent

Your son/daughter is invited to participate in a study entitled

Lesson study as a management strategy to improve performance in space, shape and orientation in Mathematical Literacy at a Technical and Vocational Education and Training college.

I, Shaik Mohammad Hassan, am undertaking this study as part of my doctoral research at the University of South Africa. The purpose of the study is to assist lecturers at TVET colleges to improve their delivery in Mathematical Literacy by becoming aware about and also be able to identify misconceptions around space, shape and orientation by learning the skills of observation as used in a lesson study process. Furthermore, it will also help the students to improve their overall results in Mathematical Literacy. The possible benefits of the study are the improvement of the design of the lecturer's future lessons, but also his/her delivery of lessons. Other benefits are the improvement in space, shape and orientation in Mathematical Literacy and strategies which management can use to improve the overall performance of Mathematical Literacy at TVET colleges.

I am asking permission to include your child in this study because it can improve his/her understanding and progress to improve his/her marks in Mathematical Literacy.

If you allow your son/daughter to participate in this study, I shall request him/her to

- Take part in an interview after the first lesson study and then after the second one. The interview will be approximately of 30 minutes duration and will take place in the lecturer's classroom as the student will be comfortable in this room because of familiarity.
- Be observed by other lecturers while a lesson is delivered and when performing Mathematical Literacy activities and solving problems. The observation will not be longer than a normal Mathematical Literacy period, which is 50 minutes long.
- To be photographed while performing these tasks in class.

- To hand in their work for analysis.

Since the interview will be digitally recorded, permission is also hereby sought for this.

Any information that is obtained in connection with this study and can be identified with your child will remain confidential and will only be disclosed with your permission. His or her responses will not be linked to his or her name or your name or the college's name in any written or verbal report based on this study. Such a report will be used for research purposes only.

There are no foreseeable risks to your child by participating in the study. Your child will receive no direct benefit from participating in the study; however, the possible benefits to education are improved lesson delivery and improved results. Neither your child nor you will receive any type of payment for participating in this study.

Your child's participation in this study is voluntary. Your child may decline to participate or to withdraw from participation at any time. Withdrawal or refusal to participate will not affect him/her in any way. Similarly, you can agree to allow your child to be in the study now and change your mind later without any penalty.

The study will take place during regular classroom activities with the prior approval of the college and your child's lecturer. You can also be assured that the study will not take place after college hours since it will be scheduled within the timetabled periods. However, if you do not want your child to participate, an alternative activity will be available.

In addition to your permission, your child must agree to participate in the study and you and your child will also be asked to sign the assent form which accompanies this letter. If your child does not wish to participate in the study, he or she will not be included and there will be no penalty. The information gathered from the study and your child's participation in the study will be stored securely on a password locked computer in my locked office for five years after the study according to the ethical process of research. Thereafter, records will be erased.

If you have any questions about this study please ask me or my study supervisor, Prof ZMM JOJO, Department of Education, College of Education, University of South Africa. My contact number is 073 105 1858/021 7621230 and my e-mail address is: mohammad.hassan@falsebay.org/za or mohammad.hassan41@yahoo.com The e-mail of my supervisor is jojozmm@unisa.ac.za and her phone number is 012 4296627; 073 488 2211.

Permission for the study has already been granted by DHET, the Academic Head and Campus Head and the Ethics Committee of the College of Education, UNISA.

You are making a decision about allowing your child to participate in this study. Your signature below indicates that you have read the information provided above and have decided to allow him or her to participate in the study. You may keep a copy of this letter.

Sincerely

Shaik Mohammad Hassan

CONSENT

Name of child:

_____	_____	_____
Parent/guardian's name (print)	Parent/guardian's signature	Date
_____	_____	_____
Researcher's name (print)	Researcher's signature	Date

APPENDIX F: ETHICAL CLEARANCE CERTIFICATE

UNISA university of south africa

UNISA COLLEGE OF EDUCATION
ETHICS REVIEW COMMITTEE

Date: 2018/07/18

Ref: 2018/07/18/4557352/14/MC
Name: Mr SM Hassan
Student: 4557352

Decision: Ethics Approval from
2018/07/18 to 2023/07/18

Dear Mr Hassan

Researcher(s): Name: Mr SM Hassan
E-mail address: 4557352@myiife.unisa.ac.za
Telephone: +27 73 105 1858

Supervisor(s): Name: Prof ZMM Jojo
E-mail address: jojozmm@unisa.ac.za
Telephone: +27 12 429 6627

Title of research:

Lesson study as a management strategy to improve performance in space, shape and orientation in Mathematical Literacy at a Technical and Vocational Education and Training College.

Qualification: DEd in Educational Leadership and Management

Thank you for the application for research ethics clearance by the UNISA College of Education Ethics Review Committee for the above-mentioned research. Ethics approval is granted for the period 2018/07/18 to 2023/07/18.

The medium risk application was reviewed by the Ethics Review Committee on 2018/07/18 in compliance with the UNISA Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment.

The proposed research may now commence with the provisions that:

1. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.

University of South Africa
Prefler Street. Muckleneuk Ridge. City of Tshwane
PO Box 392 UNISA 0003 South Africa
+27 1 2 429 31 1 1 Facsimile: +27 12 429 4150
vvww.unisa.ac.za

UNISA College of Education Ethics Review Committee.

3. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
4. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing.
5. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
6. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data requires additional ethics clearance.
7. No field work activities may continue after the expiry date 2023/07/18. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:

The reference number 2018/07/18/4557352/14/MC should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.

Kind regards,

Dr M Claassens CHAIRPERSON: CEDU RERC mcdtc@netactive.co.za

r v d- decision template —updated 16 Feb 2017

EXECUTIVE DEAN

Mckayvi@unisa.ac.za

University of South Africa, Preller Street. Muckleneuk Ridge. City of Tshwane PO Box 392 UNISA 0003 South Africa Telephone: +27 12 429 31 1 1 Facsimile: +27 12 429 50 www.unisa.ac.za

APPENDIX G: INTERVIEW QUESTIONS TO PARTICIPANTS AFTER LESSON STUDY CYCLE OF THE PILOT STUDY

1. What do you think should management's role be in the lesson study process and why would you say so?

2. How have you improved your instructional strategies in your lessons as a result of your participation in lesson study? Describe the improvement and the specific element of the process which facilitated your improvement.

3. To what extent did the full involvement of the researcher (as manager/education specialist) in the lesson study process in every part of the lesson study process impact the improvement in your instruction and lesson plans?

4. What were your experience like having the manager as member of the lesson study team a benefit towards working collaboratively?

5. In which way was working collaboratively with your manager in a team in the lesson study process different from other professional development programs or workshops you attended? Please explain.

6. What obstacles did you experience in the lesson study process?

7. In your opinion do you think there will be any benefits in implementing lesson study in this format where the education specialist is a member of the team, throughout your college?

8. In your opinion what do you think will be the obstacles in implementing lesson study in this format where the education specialist is a member of the team, throughout your college?

9. In which way did you experience the lesson study process as an effective form of professional development? If so, how and in which ways?

10. Which ways can you suggest that the lesson study process in the form of participative format can be made more useful?

11. Are there any other comments or suggestions you can make to make the lesson study process more effective and efficient?

APPENDIX H: OBSERVATION SHEET TEMPLATE

Stage of lesson	Case student A1		Case student A2		
	How it is predicted case student A1 will respond at this stage	**How they are observed to respond**	**How it is predicted case student A2 will respond at this stage**	**How they are observed to respond**	**Other comments**
1. 5 min Place all students in pairs. 3 pairs: weak pair, average pair and above average pair to be observed (case students)					
2. 5-10 min Introduction Lecturer does a brief recap of prior knowledge on - Perimeters - Areas of the four basic shapes by using data projector. Hand out a formula	.				

sheet with formulae and shapes inclusive of Pythagoras

Get students' feedback on perimeter vs. area

Ask a question
3. 5 min

Present problem in the form of a worksheet.

Also display on overhead if necessary.

Hand each student in the pair a worksheet.

4.

8 min – students

7 min - memo
.

In each of the questions below the lecturer **MAY** guide the students by asking students questions at appropriate times without giving them too much information (as if nudging them)

Calculate the length of the gate.

Give each student the (a) question on a piece of paper.

5.
10 students
5 memo

(b) Calculate how much fencing Musa will need to erect a fence around the land.

Hand out part (b) to students.

Only if students get stuck, the lecturer MAY ask the following questions:

What must be calculated first?

Which term are we speaking about here?

Do we have all the

information that we need?

Do we have one specific formula which we can use?

Now give them the solution piecemeal interactively.

6. 10 min

Calculate the area of the Musa's land.

Give each student the (c) question on a piece of paper.

Only, if necessary, the lecturer MAY ask the following questions

How can the area of Musa's land be sub-divided into (other) basic shapes?

Now give them the solution piecemeal, interactively.

APPENDIX I: EXAMPLE OF A COMPLETED OBSERVATION SHEET AFTER RESEARCH LESSON 1 – PILOT STUDY

Stage of lesson	Case student C1		Case student C2		PPL2
	How it is predicted case student C1 will respond at this stage	**How they are observed to respond**	**How it is predicted case student C2 will respond at this stage**	**How they are observed to respond**	**Other comments**
1. 5 min Place all students in pairs. 3 pairs: weak pair, average pair and above average pair to be observed (case students)	The learner would query why in pairs.	Learner was hesitant at first but moved on.	Learner would comply with instruction.	Learner was neutral.	Concern existed that the class would see that they are placed according to level of ability. But not 2 of the chosen pairs could not be had due to absenteeism. Had to re-organise.
2. 5-10 min Introduction Lecturer does a brief recap of prior knowledge on - Perimeters - Areas of the four basic shapes by making use of data projector. Hand out a formula sheet with formulae and shapes inclusive of Pythagoras Get student's feedback on perimeter vs. area	Learner would have about 80% of the basic understanding. Would have problems with Application.	Learner confirmed that basic terms were understood. Not sure of Pythagoras.	Learner would have about 80% of the basic understanding. Would have problems with Application.	Learner agreed that the topic was difficult. Further learner showed no expression.	Concern was that I would have the temptation to go deeper that I should. Handed formula sheet as learners were engaging first question.

Ask a question. 3. 5 min Present problem in the form of a worksheet. Also display on overhead if necessary. Hand each student in the pair a worksheet.	Learner would be slightly despondent when looking at the diagram.	Learner made a ooh-sound as to say it's tough.	Learner would not be showing much reaction till question is asked	Learner checked paper, but were already looking for a question.	I was hesitant to engage students as I interpreted the exercise to be an observation. Made the exercise feel non- interactive.
4. 8 min – students 7 min - memo . In each of the questions below the lecturer **MAY** guide the students by asking students questions at appropriate times without giving them too much information (as if nudging them) Calculate the length of the gate Give each student the (a) question on a piece of paper.	Learner would be eager to engage in problem solving Learner would be disappointed in self as answers are discussed	Learner looked at page but took long to start writing anything down. Learner could do the conversion. Learner remarked, I was almost there.	Learner would just get going and engage in problem solving	Learner did not write down anything at first.	It seems that the learners could not see what to subtract. It came to light that the call out symbol was confused as the gate.

5. 10 students 5 memo (b) Calculate how much fencing Musa will need to erect a fence around the land. Hand out part (b) to students Only if students get stuck, the lecturer MAY ask the following questions. What must be calculated first? Which term are we speaking about here? Do we have all the information that we need? Do we have one specific formula which we can use? Now give them the solution piecemeal interactively.	Learner would be able to find missing sides and would be able to do Pythagoras if realised it should be used. Learner might add gate.	Learner realised that Pythagoras must be used and handled it successfully. Learner added all correctly but added gate at first. Then realised it is not part of the fence. Some rounding issues were noticed. No units written down for answer. Learner did not add sides inside the shape.	Learner would be able to find missing sides and would be able to do Pythagoras if realised it should be used. Learner might add gate.	Learner realised that Pythagoras must be used and handled it successfully. Learner Added all correctly but did not show working out. Some rounding issues were noticed. Learner did not add sides inside the shape.	The worksheet did not specify rounding.

6. 10 min	NA	NA	NA	NA	NA
Calculate the area of the Musa's land. Give each student the (c) question on a piece of paper. Only, if necessary, the lecturer MAY ask the following questions How can the area of Musa's land be sub-divided into (other) basic shapes? Now give them the solution piecemeal, interactively.					

APPENDIX J: RESEARCH LESSONS FOR PILOT STUDY

Pilot study Research Lesson for first cycle

Subject: Mathematical Literacy

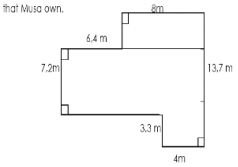
Students: Level 3 Mathematical Literacy NCV students: class of lecturer X

Topic: Space, shape and orientation

Unit: Perimeters and areas

January 2019

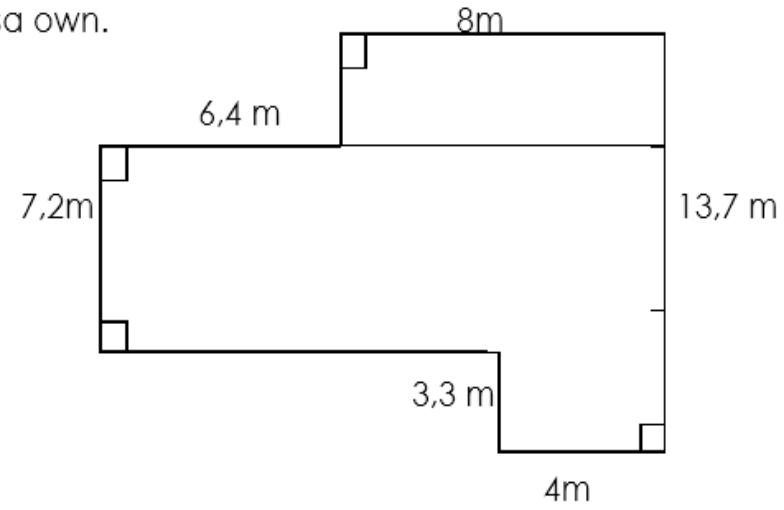
Approximate time guide	**Teaching/ Learning activities**	**Anticipated student responses**	**Anticipated teacher responses (After observation)**	**Points to notice and evaluate**
1. 5-10 min	Introduction Recap of prior knowledge on - Perimeters - Areas of the four basic shapes by making use of data projector. Get student's feedback on perimeter vs. area	Students will have a general idea. Students should be able to, but not all students. Some students might not be able to articulate the difference between area and perimeter correctly.		Display formulae of the following for duration of lesson. Perimeter and area of the 4 basic shapes **Do not remind students that for perimeter inside lines are not added - they must discover this themselves.**
2. 5 minutes	Place students in pairs.	Put each student to be observed with one almost equal in a pair.		

3. 5 min	Present problem in the form of a worksheet. Also display on overhead. Hand each student in the pair a worksheet.	Students might ask a lot of questions for clarification.	Teacher may revise only if necessary.	1. The picture below shows the dimension of a piece of land that Musa own.  Calculate how much fencing Musa will need to erect a fence around the land. (5) b) Calculate the area of Musa's land.
4. 35 min	In each of the questions below the lecturer **MAY** guide the students by asking students questions at appropriate times without giving them too much information (as if nudging them) Calculate how much fencing Musa will need to erect a fence around the land. Give each student the (a) question on a piece of paper. Only, if necessary, the lecturer MAY ask the following questions: What must be calculated first? Which term are we speaking about here? Do we have all	Students might add the perimeters of the rectangles Students might struggle with finding missing dimensions Students might not be able to link the fencing with the perimeter	Teacher may give the hints Return to characteristics of the basic shapes. Go back to basics.	This research lesson must be done in conjunction with the worksheet.

	the information that we need? Do we have one specific formula which we can use? Now give them the solution piecemeal, interactively.			
5. 10 min	Calculate the area of Musa's land Give each student the (b) question on a piece of paper. Only, if necessary, MAY the lecturer ask the following questions: How can the area of Musa's land be sub-divided into (other) basic shapes? Now give them the solution piecemeal, interactively.	Some students may not be able to subdivide correctly.		

Worksheet for research lesson

1. The picture below shows the dimension of a piece of land that Musa own.



Calculate how much fencing Musa will need to erect a fence around the land. (5)

d) Calculate how much fencing Musa will need to erect a fence around the land.

e) Calculate the area of Musa's land.

Pilot study Research Lesson for second cycle - RL2

Subject: Mathematical Literacy
Students: Level 3 NCV students
Topic: Space, shape and orientation
Unit: Perimeters and areas
Research lesson for RL2

Date: January 2019

Approximate time guide	**Teaching/ Learning activities**	**Anticipated student responses**	**Anticipated teacher responses (After observation)**	**Points to notice and evaluate**
6. 5 minutes	Place all students in pairs. 3 pairs: weak pair, average pair and above average pair to be observed (case students)			Put each student to be observed with one almost the same in a pair Lecturer must emphasise that it is a task that must be **done in a pair and to be discussed by the pair to find solutions.** Pre-arrange sorting/seating of case students and rest of students.
7. 5-10 min	Introduction Lecturer does a brief recap of prior knowledge on - Perimeters - Areas of the four basic shapes by making use of data projector. Hand out a formula sheet with formulae and shapes inclusive of Pythagoras Get student's feedback on perimeter vs. area Ask a question	Students will have a general idea. Students should be able to, but not all students. Some students might not be able to articulate the difference between area and perimeter correctly.		Display formulae of the following for duration of lesson. • Perimeter and area of the 4 basic shapes • Pythagoras Use a page for the students to sign for attendance. Have formula sheets on desk as students enter for each student. Add shapes to sheet. Insert equal signs on square and rectangle. Fix error on formula sheet:

	Quick/brief interaction with students on square, rectangle and line measurements			Area of triangle: ½ x base x height Pythagoras: $H^2 = a^2 + b^2$ **Do not remind students that for perimeter inside lines are not added - they must discover this themselves.**
8. 5 min	Present problem in the form of a worksheet. Also display on overhead if necessary. Hand each student in the pair a worksheet.	Students might ask a lot of questions for clarification at this stage. Some negative reactions can be expected.	Teacher may revise only if need be.	On the worksheet: Remove the call-out symbol as students were confused with the symbol.
4. 8 min – students 7 min - memo	In each of the questions below the lecturer **MAY** guide the students by asking questions at appropriate times without giving them too much information (as if nudging them) Calculate the length of the gate Give each student the (a) question on a piece of paper. Now give them the solution piecemeal interactively	Students might struggle with finding missing dimensions. Some students might find it difficult to convert the cm dimension to m Some students might not know what the equality sign indicates. Identify the gate.	Teacher may give the hints Return to characteristics of the basic shapes. Go back to basics.	A PowerPoint presentation will accompany this lesson plan to be used by the lecturer. A hard copy will also be provided to the observers.
5.	(b) Calculate how much wire	Students might add the		

10 students 5 memo	fencing Musa will need to erect a fence around the land. Hint: the gate is not part of the fence Hand out part (b) to students Only, if students get stuck, the lecturer MAY ask the following questions. What must be calculated first? Which term are we speaking about here? Do we have all the information that we need? Do we have one specific formula which we can use? Do you see any equal signs? Now give them the solution piecemeal interactively	perimeters of the rectangles and triangle. Might add just one side of the triangle. Students might not be able to link the fencing with the perimeter. Might calculate area. Students will struggle with conversions. Students might not see the right-angled triangle to apply Pythagoras. Students might forget to calculate Pythagoras. Students might add the gate again. Students might only add the sides given in the diagram.	What must be calculated first? Which term are we speaking about here? Do we have all the information that we need? Do we have one specific formula which we can use? Do you see any equal signs?	
6. 10 min	Calculate the area of the Musa's land. Give each student the (c) question on a piece of paper. Only, if	Some students may not be able to subdivide correctly. Subdivision of triangle might be		In the memo, label the subdivisions as A, B and C etc. Provide mark allocation to the questions as previously.

	necessary, the lecturer MAY ask the following questions How can the area of Musa's land be sub-divided into (other) basic shapes? Now give them the solution piecemeal interactively.	tricky. Students might not be able to link the dimensions to the formula.		

APPENDIX K: RESEARCH LESSONS FOR MAIN STUDY

Research lesson planning for first cycle

Subject: Mathematical Literacy

Students: Level 2 NCV students: class of X

Topic: Space, shape and orientation

Unit: Perimeters and areas

Dates: First LP meeting 10/4/19 – Present: PL1, PL2, PL3, R (Facilitator, researcher and observer)

Second LP meeting 24/4/19 - Present: PL1, PL2, PL3, PL4, R (Facilitator, researcher and observer)

Approximate time guide	**Teaching/Learning activities**	**Anticipated student responses**	**Anticipated teacher responses**	**Points to notice and evaluate**
9. 5-10 min	Introduction. Recap of prior knowledge on - Perimeters - Areas of the four basic shapes by using data projector. Recap of prior knowledge on Pythagoras Get students' feedback on perimeter vs. area	Students will have a general idea. Students should be able to, but not all students. Some students might not be able to articulate it correctly.		Display formulae (of what?) for duration of lesson. **Do not remind students that for perimeter inside lines are not added - they must discover this themselves.**
10. 5 minutes.	Place students in pairs.			
11. 5 min	Present problem in the form of a worksheet.			Problem: page 118 Amend

	Also display on overhead. Make use of Geogebra for a better visual display to show the different parts.	 Students might ask a lot of questions for clarification		question 4
12. 10 min	In each of the questions below the lecturer may guide the students by asking questions at appropriate times without giving them too much information (as if nudging them) (a) Calculate the length of fencing required to go around the garden.	Students might add the perimeters of the rectangles Students might struggle with finding missing dimensions.		The amended diagram must still be refined in terms of its labels and colours
13. 10 min	(b) Owing to the water restrictions in the area, the lawn must be replaced by artificial grass. Calculate how many square metres of artificial grass the principal must purchase.	We must still ascertain as a team what student's responses and incorrect workings will be.		
14. 5 min	(c) The principal decided to put a plastic cover over the sandpit (the triangle part) when not in use. Calculate the size of the plastic cover required.	We must still ascertain as a team what students' responses and incorrect operations will be.		

Final Research Lesson for first cycle

Subject: Mathematical Literacy

Students: Level 2 NCV students: class of X

Topic: Space, shape and orientation

Unit: Perimeters and areas

Date: 6 May 2019

Approximate time guide	**Teaching/ Learning activities**	**Anticipated student responses**	**Anticipated teacher responses (After observation)**	**Points to notice and evaluate**
15. 5-10 min	Introduction Recap of prior knowledge on - Perimeters - Areas of the four basic shapes by making use of data projector. Recap of prior knowledge on Pythagoras Get students' feedback on perimeter vs. area	Students will have a general idea. Students should be able to, but not all students. Some students might not be able to articulate the difference between area and perimeter correctly.		Display formulae of the following for duration of lesson. * Pythagoras * Perimeter and area of the 4 basic shapes **Do not remind students that for perimeter inside lines are not added - they must discover this themselves.**
16. 5 minutes.	Place students in pairs.	Three students per observer - below average, average and above average) = 9 students Put each student to be observed with		

		an equal one in a pair.		
17. 5 min	Present problem in the form of a worksheet. Also display on overhead. Hand each student in the pair a worksheet. Make use of geogebra for a better visual display to show the different parts.	Students might ask a lot of questions for clarification	Teacher may revise.	Resources: Amended problem on page 118 no 4 of L3 textbook and worksheet.
18. 10 min	In each of the questions below the lecturer **MAY** guide the students by asking students questions at appropriate times without giving them too much information (as if nudging them) (a) Calculate the length of fencing required to go around the garden. Give each student the (a) question on a piece of paper. Only, if necessary, MAY the lecturer ask the	Students might add the perimeters of the rectangles Students might struggle with finding missing dimensions Students might not be able to link the fencing with the perimeter Might not use Pythagoras to calculate the missing	Teacher may give the hints Return to characteristics of the basic shapes. Go back to basics.	See new diagram. He has put in the different colours on the diagram and broken up each question to be cut out separately. This research lesson must be done in conjunction with the worksheet.

	following questions: What must be calculated first? Which term are we speaking about here? Do we have all the information that we need? Do we have one specific formula which we can use? Now give them the solution piecemeal interactively.	dimension of the slant.		
19. 10 min	(b) Owing to the water restrictions in the area, the lawn needs to be replaced by artificial grass. Calculate how many square metres of artificial grass the principal needs to purchase. Give each student the (b) question on a piece of paper. Only, if necessary, MAY the lecturer ask the following questions:	They might forget to subtract the circle from their calculations. Some students may not be able to subdivide correctly.	Teacher MAY ask the question, what part is the lawn and what part is the flowerbed?	

	Should the flower bed be included in the calculation of the square metres? How can the shape of the lawn be sub-divided into other basic shapes? Now give them the solution piecemeal, interactively.			
20. 5 min	(c) The principal decided to put a plastic cover over the sandpit (the triangle part) when not in use. Calculate the size of the plastic cover required. Give each student the (c) question on a piece of paper Only, if necessary, the lecturer MAY ask the following questions Which formula is applicable? Which sides should be used in the calculations?	Students may perhaps not use the correct height. Students may get the units (m^2) wrong.	Teacher may have to direct them to look for a formula.	

	Now give them the solution piecemeal, interactively.			

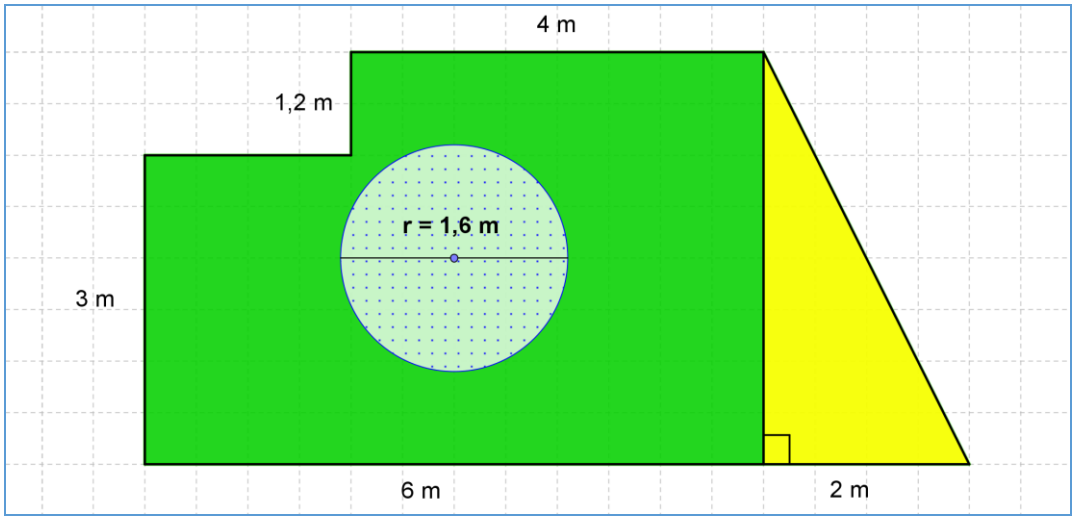
NCV Level 2 - Mathematical Literacy 6 May 2019

The principal of a school asked the gardener to design a play area for the pre-schoolers. Basic shapes had to be used.

The gardener designed a circular flower bed within a rectangular lawn.

A triangular sandpit was built on one side of the lawn.

Refer to the picture below and answer the questions that follow.



APPENDIX L: FINAL RESEARCH LESSON FOR LS CYCLE 2

Revised Research Lesson for second cycle

Subject: Mathematical Literacy

Students: Level 2 NCV students: class of Joseph Nefdt (Safety in Society)

Topic: Space, shape and orientation

Unit: Perimeters and areas

First session for revised research lesson: 24 May 2019 – PL1, PL2, PL3, PL4 , R

Second session for revised research lesson: 7 June 2019 – PL1, PL2, PL3, PL4, R

Third session for revised research lesson: 19 July 2019 – present and PL2, PL3, PL4, R.

Approximate time guide	**Teaching/ Learning activities**	**Anticipated student responses**	**Anticipated teacher responses (After observation)**	**Points to notice and evaluate**
21. 5-10 min Plenary	Introduction Recap of prior knowledge on - Perimeters - Areas of the four basic shapes by making use of data projector. Sheet with shapes and formulae will be given to all. Recap of prior knowledge on Pythagoras Example on page 118 will be used as background information and	Students will have a general idea. Students should be able to, but not all students. Some students might not be able to articulate the difference between area and perimeter correctly.		Sheet with shapes and formulae next to them. **Do not remind students that for perimeter inside lines are not added - they must discover this themselves.**

	lecturer will speak briefly about it without giving solutions. Displayed.			
22. 5 minutes	Place students in groups of three.	Three students per observer - below average, average and above average = 9 students Put each student to be observed with an almost equal one in a pair.		
23. 5 min	Present problem in the form of a worksheet. Also display on overhead. Hand each student in the group a worksheet. Make use of Geogebra for a better visual display to show the different parts.	Students might ask a lot of questions for clarification		Resources: Amended problem on page 118 no 4 of L3 textbook and worksheet.
24. 10 min	In each of the questions below the lecturer **MAY** guide the students by asking students questions at appropriate times without giving them too much information (as if nudging them)	Students might add the perimeters of the rectangles	Teacher may give the hints	See Participant lecturer's new diagram. He has put in the different colours on the diagram and broken up each question to be cut out separately. This research lesson must be done in

	(a) Calculate the length of fencing required to go around the garden. Give each student the (a) question on a piece of paper. Only, if necessary, MAY the lecturer ask the following questions: What must be calculated first? Which term are we speaking about here? Do we have all the information that we need? Do we have one specific formula which we can use? Now give them the solution piecemeal interactively. Students to participate	Students might struggle with finding missing dimensions Students might not be able to link the fencing with the perimeter Might not use Pythagoras to calculate the missing dimension of the slant.		conjunction with the worksheet.
25. 10 min	(b) Owing to the water restrictions in the area, the lawn must be replaced by artificial grass. Calculate how many square	They might forget to subtract the circle from their calculations. Some students may not be able to subdivide correctly.		

	metres of artificial grass the principal needs to purchase. Give each student the (b) question on a piece of paper. Only, if necessary, MAY the lecturer ask the following questions: Should the flower bed be included in the calculation of the square metres? How can the shape of the lawn be sub-divided into other basic shapes? Now give them the solution piecemeal interactively.		Teacher MAY ask the question, what part is the lawn and what part is the flowerbed?	Participant lecturer moved radius into centre and the circle into centre.
26. 5 min	(c) The principal decided to put a plastic cover over the sandpit (the triangle part) when not in use. Calculate the size of the plastic cover required. Give each student the (c)	Students might not use the correct height. Students may get the units (m^2) wrong. * Students might not know that the size refers to area * Students might not be	Lecturer may have to direct	

	question on a piece of paper Only, if necessary, MAY the lecturer ask the following questions: Which formula is applicable? Which sides should be used in the calculations? Now give them the solution piecemeal interactively.	able to transfer the given triangle shape to the actual triangle	them to look for a formula.	

Appendix M: Observation template

LESSON STUDY | A Handbook

Research lesson planning, observation and discussion sheet Subject, Learning Focus Teacher/observer

Precisely what is this research lesson aiming to teach? (it may be a section of a longer teaching sequence) *By the end of this lesson pupils will be able to ..... and we will know this when ...*

What learning or teaching technique is the research lesson aiming to develop? *We are hoping to improve...*

Stage of lesson sequence	Current attainment and success criteria Describe what you are looking for from them by end of lesson in the identified aspect						
	How you predict case pupil(s) A will respond	*How they are observed to respond*	Case pupil A ..... **Success criterion for this focus**	How you predict case pupil(s) B will respond	*How they are observed to respond*	Case pupil C ..... **Success criterion for this focus**	How you predict case pupil(s) C will respond	*How they are observed to respond*	Patterns / issues
Stage ... approximate time)									
Stage ... approximate time)									
Final stage ... approximate time)									
What were they able to do? (What progress have they made and how do you know?)									
Initial thoughts									

APPENDIX N: EXAMPLES OF COMPLETED OBSERVATION SHEETS – RESEARCH LESSON 1

After Research lesson | - Observation

[redacted] PL|

Research lesson planning, observation and discussion sheet Subject, Learning Focus Teacher/observer

Precisely what is this research lesson aiming to teach? (it may be a section of a longer teaching sequence) *By the end of this lesson pupils will be able to ..... and we will know this when ...*

What learning or teaching technique is the research lesson aiming to develop? *We are hoping to improve...*

Current attainment and success criteria Describe what you are looking for from them by end of lesson in the identified aspect	Case pupil A ..... **Success criterion for this focus**		Case pupil B ..... **Success criterion for this focus**		Case pupil C ..... **Success criterion for this focus**		
Stage of lesson sequence	How you predict case pupil(s) A will respond	*How they are observed to respond* WEAK	How you predict case pupil(s) B will respond	*How they are observed to respond* ABOVE AVERAGE	How you predict case pupil(s) C will respond	*How they are observed to respond* WEAK	Patterns / issues
Stage ... Q. (a) (approximate time)	(1)	Students read questions again on their own for clarity.	(2)	students close the rectangle and calculate the missing lengths (sides) First. Pythagerus was used	(3)	Students close the rectangle but do not know how to calculate the missing immediately. sides	
Stage ... (approximate time)							
Final stage ... (approximate time)							
What were they able to do? (What progress have they made and how do you know?)							
Initial thoughts							

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What learning or teaching technique is the research lesson aiming to develop? *We are hoping to improve...*

Current attainment and success criteria Describe what you are looking for from them by end of lesson in the identified aspect	Case pupil A ..... **Success criterion for this focus**		Case pupil B ..... **Success criterion for this focus**		Case pupil C ..... **Success criterion for this focus**		
Stage of lesson sequence	How you predict case pupil(s) A will respond	*How they are observed to respond* AVERAGE	How you predict case pupil(s) B will respond	*How they are observed to respond* WEAK	How you predict case pupil(s) C will respond	*How they are observed to respond* WEAK	Patterns / issues
Stage ... (approximate time)	(5)	students got confused by the word "length" and they did not link length with perimeter.	(6)	students calculated the ~~a~~ area of the rectangle 6 x 3 Then manipulated to obtain a value of just using available	=18 "c" (?) values and not	(7) Even after lecturer explained the answer to (a), one student did not know w understanding why or where	
Stage ... (approximate time)							
Final stage ... (approximate time)							
What were they able to do? (What progress have they made and how do you know?)							
Initial thoughts							

Research lesson planning, observation and discussion sheet Subject, Learning Focus Teacher/observer

Precisely what is this research lesson aiming to teach? (it may be a section of a longer teaching sequence) *By the end of this lesson pupils will be able to ..... and we will know this when ...*

What learning or teaching technique is the research lesson aiming to develop? *We are hoping to improve...*

Current attainment and success criteria Describe what you are looking for from them by end of lesson in the identified aspect	Case pupil A ..... **Success criterion for this focus**		Case pupil B ..... **Success criterion for this focus**		Case pupil C ..... **Success criterion for this focus**		
Stage of lesson sequence	How you predict case pupil(s) A will respond	*How they are observed to respond* Above average	How you predict case pupil(s) B will respond	*How they are observed to respond* Below average.	How you predict case pupil(s) C will respond	*How they are observed to respond*	Patterns / issues
Stage ... (approximate time)		Student did not know he has to do(calculate) penmeter.		Student did not know he has to calculate penmeter			
Stage ... (approximate time)							
Final stage ... (approximate time)							
What were they able to do? (What progress have they made and how do you know?)							
Initial thoughts							

Question (a)

Research lesson planning, observation and discussion sheet Subject, Learning Focus Teacher/observer

Precisely what is this research lesson aiming to teach? (it may be a section of a longer teaching sequence) *By the end of this lesson pupils will be able to ..... and we will know this when ...*

What learning or teaching technique is the research lesson aiming to develop? *We are hoping to improve...*

Current attainment and success criteria Describe what you are looking for from them by end of lesson in the identified aspect	Case pupil A ..... 9.d> **Success criterion for this focus** below average		Case pupil B ..... **Success criterion for this focus** Rani (weak) below average		Case pupil C ..... **Success criterion for this focus**		
Stage of lesson sequence	How you predict case pupil(s) A will respond	*How they are observed to respond*	How you predict case pupil(s) B will respond	*How they are observed to respond*	How you predict case pupil(s) C will respond	*How they are observed to respond*	Patterns / issues
Stage ... (approximate time)		• Question was asked regarding perimeter and inside line. • Read question again		• Student expecting friend to help him gaining clarity. • Allowing friend to do the work.		• Student was confused about play area, which shapes to be used. • Identified missing	
Stage ... (approximate time)		• Student identified Pythagoras. • Calculated without identifying perimeter.				length easily. • Confident in answering questions	
Final stage ... (approximate time)							
What were they able to do? (What progress have they made and how do you know?)							
Initial thoughts							

Example of completed observation sheets – Research lesson 2

Stage of lesson	Case student B1 Monique How it is predicted case student B1 will respond at this stage	How they are observed to respond	Case student B2 Fur (Luke) How it is predicted case student B2 will respond at this stage	How they are observed to respond	Case student B3 Grey How it is predicted case student B3 will respond at this stage
1. 5-10 min Plenary and introduction	Students will have a general idea. Students should be able to, but not all students. Some students might not be able to articulate the difference between area and perimeter correctly.	• Eager and excited for lesson • Responsive to lesson	Students will have a general idea. Students should be able to, but not all students. Some students might not be able to articulate the difference between area and perimeter correctly.	• Eager and excited • Responsive to lesson	Students will have a general idea. Students should be able to, but not all students. Some students might not be able to articulate the difference between area and perimeter correctly.
4. 10 min (a) Calculate the length of fencing required to go around the garden. Give each student the (a) question on a piece of paper.	Students might add the perimeters of the rectangles Students might struggle with finding missing dimensions Students might not be able to link the fencing with the perimeter Might not use Pythagorus to calculate the missing dimension of the slant.	• Not sure what to do • Could not answer the question	Students might add the perimeters of the rectangles Students might struggle with finding missing dimensions Students might not be able to link the fencing with the perimeter Might not use Pythagorus to calculate the	• Not sure what to do Could not answer question. • Student takes the lead in solving the question	Students might add the perimeters of the rectangles Students might struggle with finding missing dimensions Students might not be able to link the fencing with the perimeter Might not use Pythagorus to calculate the missing dimension of the slant.

After Research cycle 2

Lesson 2

How they are observed to respond	
• Eager and excited. • Responsive to lesson	Lesson very well introduced.
• Not sure what to do • Student read question repeatedly. • first to realise length is perimeter.	Students did not use Pythag. • Students find it hard to interpret the question Did not get

answe

			missing dimension of the slant.		
5. 10 min (b) Calculate how many square meters of artificial grass the principal needs to purchase. Give each student the (b) question on a piece of paper.	They might forget to subtract the circle from their calculations. Some students may not be able to subdivide correctly.	• Struggling to understand question • Unsure • Subdividing the shape was challenging • Did not know to calculate area.		• Struggling to understand question • First to mention circle area must be subtracted • Unsure on what to do.	They might forget to subtract the circle from their calculations.

6. 5 min (c) the principal decided to put a plastic cover over the sandpit (the triangle part) when not in use. Calculate the size of the plastic cover required. Give each student the (c) question on a piece of paper.	Students might not use the correct height. Students may get the units (m^2) wrong. Students might not know that the size refers to area Students might not be able to transfer the given triangle shape to the actual triangle	• immediately identified height of triangle. • Did not reach answer •	Students might not use the correct height. Students may get the units (m^2) wrong. Students might not know that the size refers to area Students might not be able to transfer the given triangle shape to the actual triangle	• used correct height Did not reach answer • Did not know to calculate area.	Students might not use the correct height. Students may get the units (m^2) wrong. Students might not know that the size refers to area Students might not be able to transfer the given triangle shape to the actual triangle	• did not know what to do • kept repeating the question • Did not reach answer. • student measured the distance of the height using a ruler.	• Did not link size to area • unfortunately all students struggled with the questions

• Struggling to understand question • Only student to use the formula sheet • Did not know to calculate area.	• Group communication was lacking • All studen tried their best to answer.

Stage of lesson	Case student C1		Case student C2		Case student C3		
	How it is predicted case student A1 will respond at this stage	How they are observed to respond	How it is predicted case student A2 will respond at this stage	How they are observed to respond	How it is predicted case student A3 will respond at this stage	How they are observed to respond	
Plenary and introduction 27301	Students will have a general idea. Students should be able to, but not all students. Some students might not be able to articulate the difference between area and perimeter correctly.	Attentive Engaged writes down notes and formulae given and revised during introduction.	Students will have a general idea. Students should be able to, but not all students. Some students might not be able to articulate the difference between area and perimeter correctly.	Listening attentively. Engaged. Participate. Follows what lecturer is saying and responds. Make notes.	Students will have a general idea. Students should be able to, but not all students. Some students might not be able to articulate the difference between area and perimeter correctly.	Listen well to lecturer and makes notes (writes down formulae).	
4.10 min (a) Calculate the length of fencing required to go around the garden. Give each student the (a) question on a piece of paper.	Students might add the perimeters of the rectangles Students might struggle with finding missing dimensions Students might not be able to link the fencing with the perimeter Might not use Pythagorus to calculate the missing dimension of the slant.	Before the question was given, the student gave each of his group members a task. One was given circle, rectangle, triangle. When question was given, students were a	Students might add the perimeters of the rectangles Students might struggle with finding missing dimensions Students might not be able to link the fencing with the perimeter Might not use Pythagorus to calculate the	Found dimension quickly. First to understand (recognise) that perimeter should be calculated and NOT area. Took leading role. Subdivided dark green	Students might add the perimeters of the rectangles Students might struggle with finding missing dimensions Students might not be able to link the fencing with the perimeter Might not use Pythagorus to calculate the missing dimension of the slant.	Quiet. Little contribution to group initially. Calculated answer independently and then disagreed with team members. Also did not calculate hypotenu	

Doubted answer. bit confused.
Immediately found
Discussed lengths of 8m and 4,2m.
answer with C2. Confused. Started calculating

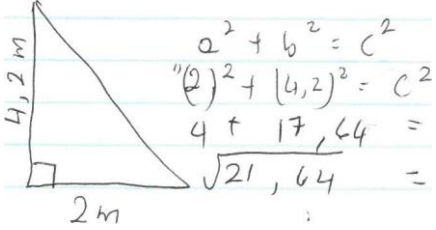
(2)

	C2	Immediately understood when solution was given	C3		
	missing dimension of the slant.	and quickly solved hypotenuse by himself. Ⓜ			
sbood diately area of le had to calculated. radius value ctly. lated area ircle. pped here. ealised that as had to subtracted done about n. before of this on.	They might forget to subtract the circle from their calculations. Some students may not be able to subdivide correctly.	Knew to calculate area. Used radius correctly. Calculated area of circle. Thought this was end and final answer. Stopped here. Failed to read question. Was guided by lecturer. Quickly calculated area and stopped again. C1 told C2 about subtraction.	They might forget to subtract the circle from their calculations. Some students may not be able to subdivide correctly.	Followed team members. Calculated area of circle. Stopped here. Thought this was answer. Worked independently and compared answers with group members. Done 4 min. before end of session. Realised mistake as student C1 when solution was explained.	
lecturer ssed solution, realised that used the area the entire rectangle 4, 2) and that did not take account the issing" little rectangle the left (top corner).		Then did last step quickly. Done		& 4 min. before end of session. Very excited and confident that answer was correct. Turned page over so that other groups cannot see their answers, Quickly realised mistake when lecturer explained the solution (calculated area of entire rectangle). Enjoys "shouting" out correct answers.	

Ⓜ Put up hand to say he got it but did not actually understand it until it (solution) was discussed.

2 lengths

APPENDIX O: EXAMPLES OF STUDENT'S ANSWER SCRIPTS IN OWN HANDWRITING



$a^2 + b^2 = c^2$

$(2)^2 + (4,2)^2 = c^2$

$4 + 17,64 =$

$\sqrt{21,64} =$ 4,7 1

=

= m

= 2 + 4

= 22, 4 m

= ~~24, 4 m~~)

S

22/7 (1,6)^2 ← Area of Circle

22/7 x 2, 56

8, 04 m^2 →

= L x K ← Area of Rectangle

= 4, 2 x 6 " 22, 8 m^2 "

= 25, 2 m^2 →

A. of C minus A. of R

, 2 m^2 − 8, 04

17, 16 m^2 →

2019

$17,16\ m^2 - 2,4\ m^2$

$= 14,76\ m^2$

Rafeeqah Booysen

Mathematical liter

(a) $P = 8 + 8 + 4,2 + 4,2$

$4,2 + 4,2 = 4,2m^2 +$

$= 17,64$

$= 21,64$

$\sqrt{4,64m}$

= 24 L}

$3,14 \times 1,6 =$

=2161 M

$\times 1,6 \times 2$

$8,04m^2$

$= 25,2 - 2,4m^2$

$= 22,8m^2 - 8,04m^2$

$= 14,76m^2$

$6 \times 4,2 \quad 2$

$= 2,4m^2$

$= 6$

$= b \times h$

$= 2m \times 4,2m^2$

$= \frac{1}{2} \times 2m \times$ 14 , z M

Perimiter

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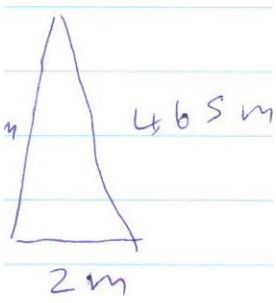

(十し.主やし，2

2 2

21+6=

21,64

√21,64

4,65m

2×3,14×1,6m÷2

=2,51m

L×B

2π×r 2

3,14×1,6×

8,04m²

二-乙Ⅱ・ x k

B×h

2m×4,2m²

8,4m²

$$\frac{1}{2} \overset{x}{\times} 2 \times$$

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ュし，L心一3 ，0耳(下,14 x i

=12.36

~~2m + 4,65m + 4,2m~~

Thando

$c^2 = a^2 + b^2$

$c^2 = (2m)^2 + (4,2)^2$

$c^2 = 4 + 17,64$

$c^2 = \sqrt{21,64m}$

$c = 4,6m$

Perimeter $= 4m + 1,2 + 3m + 6 + 2 + 4,6$

$= 20,8m$

$l \times b$

$= 6m \times 4,2$

$= 25,2m^2$

Area of circle $= \pi \times r^2$

$= 3,14 \times 1,6$

$= 5,02m^2$

$25,2 - 5,02$

$= 20,17$

$\frac{1}{2} \times b \times h$

$= \frac{1}{2} \times 2m \times 4,2m$

$= 4,2m^2$

APPENDIX P: EXAMPLE OF A PARTICIPANT LECTURER'S JOURNAL

PL4

4 April 2019

Impressions

- Some students might have different levels of background knowledge for the topic of space, shape and measurement. This may cause some groups not to reach task completion within the specified lesson time.

Experiences

- The collaborative approach brings in new ideas as it stems from a collective input of experienced professionals.
- This session was useful because we received a clearer view of the actual lesson to take place. The lesson will take place as a student-centred approach.

Feelings

- We need to consider that students will take time to grasp application of space and shape concepts, it will require higher order thinking skills.
- Students will be motivated to solve the questions, as it is a new approach for them.

Reflections

- Leading questions will help guide students through the problem solving process.
- We need to be careful of making the questions too complicated, it might steer students' attention away from the lesson.
- Problem solving methods as a student centered approach takes more time to pursue, which will need efficient time management of the lecturer.

APPENDIX Q: EXAMPLE OF RESEARCHER'S JOURNAL NOTES

Meeting for research component – 24/4/19.

*my reflections: JN, SV, IS, MH, MF

One participant adjusted the problem
Collaboration is also social interaction
To do the lesson in a ~~data~~ projector in class
Muzaffer left at 15:45
Professionalism
Student-centred and so nice
Problem is time.

Monday 13:50 29/4/19. 6th meeting
Send reminder and other stamp.

*. My own reflections on this meeting
, Noticed that two participants were passive in the discussions, until (R) prompted a few questions

One p said that the collaboration is very much like social interaction which is part of collab.

I first asked p to jot down their experiences for each meeting on certain points.

I liked
R. discussed the over-arching goal and the input was good as some p amended it to include lecturers and ML managers. The group also amended the sub-goal to include improve understanding in ML ..... quality of T+L ---

The group started by reviewing the LP and made a few amendments to the existing one. One p re-designe the worksheet and it was decided to add 3 questions. It was also decided by the group that to give a question and then to discuss. Good comments and input was made

The group was very enthusiastic and the felt that LS has huge benefits for all end managers alike. I also feel that p are inspired and starting to know a bit more about LS and how it works

~~I did~~ Time did not permit the R to discuss the elements of a good LP

Some p said that LS is very good, but time is a problem

Next time, let all p agree on a decision and not only some.

I also found that the better you are prepared for the session the better you do

Yo^g)

11 amended/charged
table for journal ✓

6/5/2019

My impression is that there is now a better understa
of LS amongst the members

Lectures ~~are~~ were very eager and they ~~are~~ were also very enthusiastic and realised that they can learn from each other. They ~~are~~ did also look at LP in a different way as well as the content. Two of the members who were very quite ~~are~~ were now also making comments and input.

There was openness and an earnest for the process and for the collaborative process. They were sharing ideas, lecturers went to C from each other and a great camaraderie and collegiality was developing. There was dedication and a positive attitude

The issue about DA wanting to participate must be carefully addressed, seperately,

DA spoke about the time that needs to be devoted to LS and she also saw this as a problem in the time table. This can be an idea/challenge for M and a strategy can be worked out to work around it. I mentioned that all Lt has identified time as a problem.

I also spoke about my ~~focus~~ being on management

APPENDIX R: SEMI-STRUCTURED INTERVIEW SCHEDULE FOR PARTICIPANTS AFTER THE LS PROCESS

Semi-structured interview schedule for participants after the LS process

General questions

1. Describe your general impressions and experiences of participating in this LS process.

2. How and to what extent have you improved your instructional strategies in your lessons as a result of your participation in lesson study and collaboration in a team? Describe the improvement and the specific element of the process which facilitated your improvement.

3. How did the LS process improve your ability to focus on how your students think and learn? If it did, can you give an example? If it did not please explain why not?

Specific questions related to the research questions (emphasis on management)

4. To what extent did the involvement of the researcher (manager/education specialist) as a participant observer in the lesson study process in every part of the lesson study process impact on the improvement in your instruction and lesson plans?

5. How did the participation and the collaboration between the participants together with management in the LS process brought about a positive and supportive environment and how did your relationship with your manager change through the process?

6. How can managers use the ideas and the effectiveness of the LS process in the teaching of space, shape and orientation at TVET colleges and how can they use

it in other parts of the syllabus and other subjects? How can this assist in looking differently at the curriculum?

7. To what extent did working collaboratively together in participation in the same field for a common purpose assist in bringing about collegiality in the group? (Explain collegiality)

8. In which way did the sharing of ideas and knowledge in the LS process increase your confidence and how did it motivate you?

9. In which way and to what extent did the manager in a participative capacity contribute towards building confidence in you and empower you through the lesson study process?

10. What role did the manager play in the LS sessions which you were a part of recently and what do think should a manager's role be in the LS process?

11. In which way and to what extent did the LS process through participation and collaboration bring about respect and trust amongst the members (lecturers and the manager)?

12. Now that you were a part of LS how would you start your own team implementing the LS process at TVET colleges and for your subject and how will you get managers involved in the process?

13. In which way did the LS process within a team in the participative process of collaboration empower you to make decisions freely?

14. What suggestions would you make to managers to effectively implement LS at this college and the whole TVET sector?

15. Which ways can you suggest can the LS process be modified to include managers in a bigger way to make the LS process more effective and transform colleges? In many instances where LS is implemented or researched there is no management involvement. An instruction is given by a manager to try it out and the team implements it. In your opinion do you think there will be any benefits in implementing lesson study in this format where the education specialist is a member of the team, throughout your college?

APPENDIX S: INTERVIEW QUESTIONS FOR STUDENTS AFTER THE FIRST RESEARCH LESSON

1. What did you enjoy most about the lesson?
2. What did you enjoy least about the lesson? Why?
3. What did you learn?
4. What can you do now (or do better) that you could not do before?
5. Why can you do it now (or do it better)?
6. What prevented you from doing it (or better) before or what did you not understand before?
7. What was the error (or misconception) in your thinking before?
8. How can you improve or what can you do to improve?
9. Which aspect(s) of the teaching worked best for you?
10. If the same lesson is delivered to another group, what would you change? Why would you change that aspect?

APPENDIX T: INTERVIEW TRANSCRIPTS OF SEMI-STRUCTURED INTERVIEWS WITH PARTICIPANT LECTURERS

Participant Lecturer (PL 1)

R: The first question I want to ask you is, before you became part of LS, how have you done this part of the syllabus, how did you plan your lessons, and how did you deliver your lessons before the LS process?

P: I think with my background as having taught mathematics for so many years. I mean my approach has always been to work from the formula. So. when I would introduce it, I would firstly go through the basic shapes of the four basic shapes (clearing throat) and then I would start with perimeter which is the basic and I would explain it as a distance around a around a shape and then from perimeter I would go on to area and then from area I would move on to volume. My approach is that you work with the same shape and that students can see the progression from meters to meters squared to meters cubed and I always try and show them, you know like with area if you were to have a 3 by 3 and you can subdivide into nine blocks of one by one so that I can count and I try to emphasize that a formula is merely a tool a method for helping because its easier. a rectangle which is 2 x 3 but what if it is 200 by 300 and the numbers are numbers are increasing it's getting bigger and bigger so ya and then also visual.

I have little shapes in my class, objects so I will show them what a pyramid is, I mean, I know they don't really do that in mathematical literacy, but I will show them what a cube is and because they do make use of the mathematical terminology, like a rectangular prism, for example I will try to link that to a box and I will bring practical examples in like a matchbox or a Coke can, or you know something that they're familiar with or a party hat to make it more real, yeah or cone in the street, you know, so we'll have that type of discussion beforehand and a dice and things like that. Uhm yeah, and then also I'll do that what they

know you know what they can observe and then I'll go to the perimeter and go to the formula and then every calculation from there onwards I will start with the formula, and look at the missing values for the calculation.

R: Describe your general impressions and experiences of participating in this collaborative LS process. How have you improved, what were the major benefits for you and what does it mean to you?

P: Okay for me the discussions with the colleagues was actually really a great experience because we don't often have time that we set aside to discuss lessons. Uhm, so I felt that the sharing of our of the ideas was very good. That was very good hearing other people's input, their views, their opinions, their approaches uhm and yeah, and then I just realized more and more that lesson plans need to be a priority. You know, that is the basis that our lessons will be shaped on or formed on. So, yah I really enjoyed listening to my other colleague lecturers and my colleagues that was a good experience.

R: Okay, so some of the questions might overlap but it's not really that overlapping if you really listen to it very carefully. How and to what extent have you improved in your lessons as a result of the participation in this study in combination to collaboration in a team. Describe the improvements and the specific element of the process which facilitated your improvement.

P: I think breaking the lesson plan up into like time slots of like five- or ten-minute chunks. And then also the anticipation of what the students are going to answer. I don't think that's always you, people pay a lot of attention to and then what I enjoyed about the lesson itself was the observation and me being given the opportunity to just sit and observe, uhm, because when you are in a class you have the sole responsibility of teaching, observing, helping, walking around, providing support and it was nice for me to almost just to be part of that responsibility. I didn't have to teach, I didn't have to walk around, I could just sit and focus on the students that were assigned to me to observe. Yeah, I wish I

could do more of that and then also afterwards listening to the discussion of my colleagues because like I mentioned I mean I didn't realize how but that will come in later in another question is, well how the student's self-esteem actually, how important that role was until I listened to the feedback of (PL3 - another participant) and (PL4 - another participant) was and then, you know, how everything just fell into place.

R: Okay, and what do you think about the self-esteem of the colleagues? Do you think their self-esteem also improved?

P: I think their self-esteem, yes I think with the other two colleagues being younger, and not as experienced as maybe (PL2 - another participant) and I, I think they sometimes they have a lot to offer but I think they may be felt sometimes that they were also still learning.

R: Oh you're talking about the colleagues, the younger ones?.

P: (referring to the younger colleagues). They were younger. At the beginning they were very very quiet, afterwards they came into the rhythm of things that yeah Yeah, I think they still have to sort of the feeling that they must learn from the more experienced lecturers. But I mean they had very valuable input to give I mean obviously we know more about we've seen more students. but it was a whole idea of getting everybody's participation. Yeah, but I also learned from them, it is not like only learned from us (referring to the more experienced lecturers).

R: So, how did the LS process improve your ability to focus on how your students think and learn? If it did, can you give an example? If it did not please explain why not?

P: Yeah, I think of with having taught this for a couple of years, I mean it was I could almost anticipate what the students were going to do. So, I would say maybe 80% of that. I mean it wasn't new to me. But what I did pick up was the fact that so many students. Like I said the confidence, I mean, it's not doesn't

mean that the strongest students necessarily can answer all the questions, but they think they can, and that helps them quite a bit because they'll jot a few things down in the exam, I think, for which they can get marks, whereas students who that are not as confident maybe won't even write down what they think, and then that they missed an opportunity and that was something that I shared with my classes what I said now, when we do revision for September, we need to build on your self-esteem and you have to do as many examples as possible so that you can feel confident that you know what to do. So, I already that I could share with my own class.

R: But did that come about because of LS or before?

P: Yes, yes I wouldn't have seen that before and then another thing that I picked up in the research lesson and was also that students they are very hasty, almost, you know they they think they've got the answer. They don't read the entire question then they'll stop midway. Mmm. Then they will only get third of the marks, then loose marks or whatever and don't realize that they must continue and go further. Yeah, So basically, the LS then gave me an idea of how to improve your focus on the students more often. Yeah, but I remember when I started to teach ML for the first time, that first exam the students had, I mean I didn't invigilate, but I was called to all the venues and even my, I'll never forget it was a student the name was Tanita and she was one of my strongest student and she called me so many times just to confirm, and if I think back, I mean like a flashback did you confirm it, and, am I on the right track? Okay, and she was but that confidence, they weren't sure, and I mean and especially I also remember that one question of a volume of a swimming pool. Okay, and I mean it was that one and she knew how to do it, but she wasn't sure so this makes actually sense it's like a full circle almost.

R: I'm going to move on to the more specific questions related to the research questions and it is obviously an emphasis on management. So, from your impressions of the LS process and your experience to what extent did the involvement of the researcher (manager/education specialist) as a participant

observer in the lesson study process in every part of the lesson study process impact on the improvement in your instruction and lesson plans?

P: All right. I think I think it was done more thoroughly with the researcher being part of it, because I think we're in that sense very similar to students. You know, the way you only do up until a certain point and then you stop, so I think with a researcher being present it's almost as if just analyzing it more. I mean is this really everything that you've got to say and you think about it as if from a different approach, different angle, yeah and instead of just rushing through it, it sort of gives you time to pause and think that I think that my that makes a big difference, because I don't think it would have necessarily been done that thoroughly. if despite is the fact that we came up with the ideas as well and participated. I think the rate at which the process was done better was different with the manager being present.

R: Thanks, OK. How did the participation and the collaboration between the participants together with management in the LS process bring about a positive and supportive environment and how did your relationship with your manager change through the process?

P: I think this a great opportunity for managers and lecturers to work together and it was never done before and I think you must embrace the fact that other people have also have input. You know, I don't think of either (PL4 other participant) and (PL3 other participant) and seemingly younger that they can't contribute because it depends on the on the experience. And so y'all I also think I think the sharing and the opportunity to work together and be creative together and share ideas, also the respect I think, we respect each other and despite experience or lack of experience. I mean, I value their contributions and I don't know I just realized I mean they are an asset, you know, they are a valuable asset to the team. So, and it's also opportunity for them to grow, hopefully and to learn an opportunity to grow I think that is important because (PL4 other participant) is new in mathematical literacy. Yes, but (PL2 other participant) it

was also nice for me because (PL2 other participant) has a different view to things, which is nice really I mean I could hear he's a little bit more mature and experienced. But I mean that was also nice to hear. Yeah. Yeah. Yeah. So basically, that was revealed to me then I would say it was positive in support of it was a supportive because we have that relationship here at this campus as well. Yes, definitely we should share and learn and it's and you must feel free that if you don't know something, ask. Yeah, it's not gonna you know, be less on you or anything, it is an opportunity for you to learn and for everybody an opportunity to learn and grow. That is the right approach to take.

R: How can managers use the ideas and the effectiveness of the LS process in the teaching of space, shape and orientation at TVET colleges and how can they use it in other parts of the syllabus and other subjects? How can this assist in looking differently at the curriculum?

P: That’s a difficult one. As a manager because I mean you manage people so you almost want to encourage them to come up with these ideas themselves, sort of I suppose and then you want them to share it with their colleagues. now in other subjects and other syllabi, I think the managers will have to speak to the other managers because we don't know the content of other subjects so they must be more. I know we struggle to mean to to get that right where we even a me I think we are sharing an office and I mean and we don't even really like share things in English and Mathematics in terminology, but I think that is a need, but as a manager because then you most likely guide the process, think you need to build a good relationship with your staff. Okay, you know, so that they can feel open to share with you but nothing that they say will be held against them, you know. So because a manager is seen as a checker and a verifier and almost like a disciplinarian type of thing. So as a manager and it obviously helps. I mean if you are a manager of something that you know that you've taught yourself in that'll help you to guide the team, you know, that is that is not easy because I would say like for instance curriculum is more a managers

forte for implementing the curriculum etc but through the lesson study process especially now with space, shape and orientation just focusing on it because that is what we have decided on.

R: Can, whatever came out in the lesson study process especially with our problem that we have used can that feed into the curriculum making the curriculum little bit differently, maybe? Explain.

P: Yeah, I think it can. I think it can because the lesson study will be able to identify the gaps. Yeah. I mean maybe for the curriculum you must set time aside to address the gaps, before you deal with the more complicated. I don't know about watering down the syllabus I know there were people asking for that, like making it easier but I am not hundred percent sure. Myself and my colleague discussed it and I am not in favor of watering it down but approaching it in a different way. Maybe at focus groups we can say we have done this LS and the way it is in the curriculum or textbook it is not how it's supposed to be because the students felt differently about it and stuff like that and we think now it should maybe change to this or amend it to this way keeping in mind that different classes respond differently to the same thing. So, I mean you may have a class of brighter students, where you won't change it into smaller chunks of information, but when it is a weaker class you will change it into small chunks of information and some of the children who already know that they bored by that smaller chunks and that's why it's important that it must be pitched you know.

But I think it can and it will influence the curriculum if you are going to change your lessons, because this is what you (the researcher) have given us, I think a methodology to address problems which come up in your classes and to address it on the lesson planning stage. So, if there is an error or problem and the students are struggling how can you change that lesson plan or research lesson. So that that problem area or loop hole is addressed. So that is a methodology of saying identify the weaknesses and plan to address the weaknesses, I think. And maybe you can adjust the curriculum in the sense that you can at level 2 stage take for example, because they do the same things up

until level 4 and at level 2 stage you can do more demonstrations and models and measuring. So, I think it definitely will influence the curriculum yes unequivocally it will influence the curriculum in a positive way. But a lot of time and discussion is needed. Time must be set aside. Yeah. Because the people with the experience on at root level they need to communicate with the managers.

R: Okay. So, is there anything else you want to add? Okay, right then come to number seven to what extent did working collaboratively together in participation in the same field for a common purpose assist in bringing about collegiality in the group? Explain.

P: Ok well I mean the shared ideas I mean four, no five people can think better than one so they came up with ideas and suggestions that I would not have necessarily thought about myself, and I think if anybody else mentions something interesting it inspires a new thought in you, so you know so you come up with another plan. And working together ya I think the team work. As a manager, I think people could just see you as a colleague in that sense you are on the same level as all the others and we did not see you as a manager(researcher) in terms of LS you have years of experience and you are worthy of leading the team, which is not always necessary true that we have more experience and thus know more. So, what managers can learn from this participation is that managers must not see themselves as managers in this process of LS. You are really on the same level and communicate with people (especially subordinates) more often because we don't always have time to do that because normally the manager instruct or, we ask or request or whatever guide, filter down, cascade and you must also just sometime work together. LS teaches managers to have a more bottom up rather than a top down approach. I think we all appreciated it. I think so we all felt like that.

R: In which did the sharing of ideas and knowledge in lesson study increase your confidence?

P: Uhm, I think for me it was more like an inspirational thing because I could see how the students enjoyed the working in groups, because we don't often let students work in groups for example, and push their desks together you know, for me it was nice to feel the vibe from the floor, they were very encouraged, and in the interview with the students they also liked the student-centered approach and they were actively involved. They did not get everything correct but they were inspired and the lesson went by pretty quickly. So, I thought, for the preparation for the mid- August I want to try some kind of an informal competition which is not structured which will just happen naturally, so I want to see if I can try and inspire them that way when I do revision. And I really, shame and sometimes you feel the students don't give you feedback, you ask them a question they don't add anything to the lesson, uhm, but as I say there is a time and a place for it you can't have it for every lesson, like this, but I think we can have more of it (LS). It was nice to see that the students can actually enjoy ML and space and shape which is normally a topic that they dislike.

R: And for yourself did it motivate you and give you more confidence?

P: And for myself it did motivate me and confidence yah confidence maybe in reading students better and I think in that sense to try something new, a new approach but yah and it was just the fact that students can still enjoy. You must just put in a different approach but I don't think confidence in the sense of how I will necessarily teach that because something that I'm pretty sure the topic that I'm pretty confident with.

R: In which way and to what extent did the manager in a participative capacity contribute towards building confidence in you and empower you through the lesson study process?

P: I think maybe in the breaking down and the clarification of the different steps may be breaking it down the lesson in smaller chunks. I mean what might be covered in the first five minutes, you know, just a bit of guidance in terms of

structure. Yeah, and then also giving the researcher also allowed the participants, I mean to contribute quite a bit, you know, so give a giving the time to think and rethink. Yah it was just basically the time that was given that was allocated which was a luxury not that it was something that we were forced to do in terms of setting time aside which we don't really give ourselves which I think was valuable. This time was beneficial. Instead of just wasting it away you actually did something good. And you realise that you can't always just spend ten minutes on it I mean, maybe you need two hours.

R: Okay, what role did the manager that maybe follows from the other one? What role did the manager play in the LS sessions which you were a part of recently and what do think should a manager's role be in the LS process?

P: I think the manager's role is a guide who gives guidance and then also an observer, maybe a participant observer when it is needed when it is asked to give the group guidance, but not be prescriptive, but rather to observe and listen.

R: In which way and to what extent did the LS process through participation and collaboration bring about respect and trust amongst the members (lecturers and the manager)?

P: like I said before I think the respect that we feel that everybody's got something to contribute. I mean you've got different experiences, you have different personalities, uhm but I mean together we've got the same goal and its almost as if the team is more representative of what we deal with in the classroom because you also sit with different personalities some people. And you have a different class and you can bring that into the into the discussion. And the trust. And so on, that's what I what I think.

R: Anything else?

P: like yah we had good people in the group people who know what they're doing and they were enthusiastic. They became motivated, but just demotivated

by the amount of work, the paper work, the lack of student interest. Those things, But, if we work together like this it becomes inspirational.

R: Now that you were a part of lesson study how would you start your own team implementing the lesson study process at TVET colleges and for your subject and how will you get managers involved in the process?

P: I'm already involved in that with my team, but I think maybe if we can get allocated time on the timetables or maybe every second week. We can put down aside and purposefully, you know, discuss, maybe we do one lesson at a time, You know in the end it will do cover the whole syllabus or the cover or curriculum or just at least inspire people or getting like started to think in a different way using LS. I think that's the job of a manager being the driving force, to make the arrangements set the time aside. Okay, make sure it happens, be present because I think it is important for the manager to be present, just to make sure that things happen, use the full time allocated for LS meetings and discussions.

R: Can LS be taken further by the members that participated at TVET colleges by one of the members becoming a champion for LS at the TVET college?

P: Yeah, of course one of the members can easily now become a champion for LS also because this was the first time at the college so it took a little bit longer. But I mean now with people knowing exactly it won't it doesn't necessarily have to take so long, you know, because, and you won't have time to teach the lesson like we did with the research and to reteach the same lesson but I mean, you can cover the you can cover most of it beforehand. Yah no definitely. Yeah. So basically what I am then saying is sometimes you cannot use the whole process of lesson study, but maybe you can take elements from that like observation, like you can maybe just one day coming together and plan a lesson together on a certain topic that may be giving you problems or giving students problems and stuff. Yeah, and you can also ask the lecturers come and be observers in your class and to sit with your students then maybe you can be an observer in

somebody else's class.

Not observe the lecturer as much because you want to observe the students so that you can increase those things. That's what I would appreciate because I said to my classes as well, you don't have time to look over everybody's shoulder to look at the mistakes that they making and here, it's almost as if there are more of you present in the class, which is very helpful and the students also mention something like that. They'd like to be observed and people can tell them where they are really going wrong like for math we have maths assistants for DEDAT. Yes. Yes, but the mathematical literacy maybe need the same thing, but it's not as big a priority.

R: OK we're moving on very nicely. In which way did the LS process within a team in the participative process of collaboration empower you to make decisions freely?

P: Yeah this relationship with my team in any case (through the lesson study process) that I don't want to make the decisions by myself. And I think this was just more of a like reinforcement of that if I can call it that and that I can still learn after all these years. I mean yah we know more we've been through the mills, but I mean we can still contribute something new and no one is going to shut it down because times change and things become modern and technological. So, decisions are freely made. Yeah. I don't think the participants had a problem with that and for me as well, I would like to think that we've always had this open relationship if you want to call it that way. Uhm, so now I don't feel that I was restricted actually like before yeah, I haven't really when it comes to a class, you know, you you've got the ability to do in your class what you want to do as long as you can deliver the message I mean you can use technology, you can take your students on an outing, take them outside to measure things physically. No, I would not say I was restricted myself and I could make decisions freely in the lesson study process and in participation.

R: What suggestions would you make to managers to effectively implement LS at this college and the whole TVET sector?

P: Oh, I think firstly is the time, putting the time aside, scheduling the time for that specific purpose. I mean you cannot just put time aside it has to be for and with a purpose. Otherwise. it is just going to be a discussion of challenges. It must be put down for this (lesson study) and it must be scheduled, it must be structured. We must say we're going to discuss space and shape this month and then next month you want to pay attention to numbers. You know that you've got a goal that you need to work, and then sharing I would say within the college with like we said before with the departments and then maybe with other colleges. And I think that is where the actually the manager will come in because you'll be the drive the driver of the process. You need somebody external that can be part of the process. But who can also, you know make the necessary arrangements and things like that. Yah so time must be must be a priority. Otherwise, it is not going to happen.

R: What do you think is the future of lesson study?

P: I think if the lessons are thought through better and you know especially if you think that you can you can design a lesson plan in such a way that for new lecturers that it's, you know, you can guide them better. So, it will tell them it must almost say these are the anticipated. These are the gaps. These are what from experience what we found students don't know, uhm prior knowledge that they still need so that'll help newcomers. And then also people that were you because I mean I learnt in that research lesson and I taught this a couple of years, and then Yo, maybe just have a more comprehensive document almost, that must also be workable. People don't want to read through pages and pages of documents and text. So, people must really be able to see the benefit from it and maybe not for all the lessons maybe a few Exemplar. So, I think there's almost be like a guide or extra can't really because you don't want it to go to waste. Yeah, and if people can see the value in it, or maybe choose a topic just do it for a topic and let people implement that and then see the value of it and

they'll be more motivated themself to apply to the other topics.

R: Which ways can you suggest can the LS process be modified to include managers in a bigger way to make the LS process more effective and transform colleges? In many instances where LS is implemented or researched there is no management involvement. An instruction is given by a manager to try it out and the team implements it. In your opinion what benefits if any will there be in implementing lesson study in this format where the education specialist is a member of the team, throughout your college?

P: Like I said before I think definitely it's important to keep the people on track, to guide them to make sure that it's not done haphazardly or that and it is done thoroughly. And then I think obviously I mean if people want to see the benefits of it you need to track the results. So maybe that manager can also take responsibility for the managing of like we do with the baseline assessments. Let the students do the test beforehand let them do a lesson study like the one we have done now and then test their progress again, uhm because I mean that will also help in refining the process, uhm yah, and I think if we as lecturers also see that you can fix the problem at level 2 level, you not gonna know we feel that we don't teach it properly the first time or students don't get it, then when you do revision for September, we have to reteach it the things that we did in June so I know that's going to happen now for me. Then when you get to level 3 you have to do what you've done in level 2 and then in level 4 you must do the level 2 work again, but if we can make sure that they get it once off it will also make work of lecturer easier and you can maybe spend time on more creative things instead of you know drilling the same old stuff over and over again. yah and the management is needed because like I said, I think the driving force people do need a push. Yes, as soon as you don't have anybody setting targets or submission date or deadlines or whatever, then there is no structure. And LS will fall flat. Like I said to my colleagues now the reason we have the POE (Portfolio of evidence) and POA (Portfolio of assessment) moderation. Now people think

okay we have to do this and that, get the ICASS up-to-date, moderation and get the reports, but that's the whole purpose of the manager, I think the same with the lesson plan and the involvement of the manager, it will be most effective if there is a manager present.

R: And were there any negatives you picked up from the lesson study process?

P: The only negative that I can think is the time issue. It was a very informative but in reality we won't have I don't know how many hours? seven hours to spend on a fifty minute lesson unfortunately. So that's why maybe if we do one lesson at a time or we do an exemplar but I mean still people are going to be part of it and then it's not going to really you have to just keep on driving it until maybe do a couple of lessons will take two or three lesson per trimester or per semester until over few years you've covered the whole syllabus on those areas that is giving problems. Yeah. To start maybe we can like look at space and shape like we have done now because it's always been a challenge but the finance and stats maybe not as much and then I would say maybe numbers some of it because that filters right through. So, I would say those two could be the key areas to start off with Yeah. I think that's it.

R: Is there anything else you would like to add about your other impressions and your experiences and feelings about lesson study?

P: Yeah, I think lesson study opened my eyes as well, you know as to what can be done, what is available and what we actually often lack in doing, due to certain constraints. And then also the positive thing was for me how to see how the lecturers and students really engage and got engaged, how, they got involved how much they enjoyed it. Okay, I had a similar. I took another person's class a couple of years ago where I I didn't teach at that point and we also wanted to test this engagement thing and I designed a little almost like games, for a lesson and I did with this class and to me because I mean it depends on your personality as well. If you enjoy a class that feels chaotic, you know, then it's OK, but if you more a person like you used to listening, students must be

orderly and that class was just all over the place. I had chocolates and the whole reward thing going, but the students just loved it. I was flustered at the end of the day because I feel yoh this was busy and I mean, but they loved it and they wanted more of it. So, I think you need more than the one lesson as a lecturer to get used to that. And you need to think of you know, because I will just give a chocolate to the first guy who completed the questions, for example, like match column A to column B. and then this one would call me I ran from the back to the front and then the first guy would get a chocolate but then the first guy wasn't necessarily the one who got everything right, so later you have to say have to say I'm gonna give you the chocolate to the one who is first the fastest but with all answers correct. So, you know those things also takes time. You have to go like through a first trial run to realize but I mean that was what was very nice for me in this LS. I think the students learnt a lot and if you think that they have actually done this (space shape and orientation) before June, it was supposed to be easy but they enjoyed it they loved it. They wanted more.

R: Did you check on them all about that?

P: No. No, it was just the two classes that we took. Just the verbal feedback said they loved it was all of them were involved for the entire lesson. It was really and I had a game where, Yeah, you would match people. You would let them do the questions. For example, then you would match them and then they had to have the same answers and then if they didn't have the same answers because they had the same questions but it was structured differently, you know, it was in this different order. Then they had to check with each other and if my answer different from different from you differed from yours, then we had to find out why, and one was correct and one wasn't. So that was another game we did and I mean I'm students you like I said, they loved it, but I never did it again, but I felt that I needed more periods to refine it. So that's the same, here. I mean every time that you do it, I mean you will do it better like the second time was already better than the first for this lesson study process. But it's hard work, but in normal classes we don't reflect on a lesson we just look at a lesson we gave

whatever and that's it, you tick it off. But we never reflect but in lesson study it least gave you that time to reflect and collaboratively to reflect and each one has a say in to the debriefing thing and see how this lesson. Usually we don't do that. That will make more effective use of your time and often we spend so many hours and minutes on a topic and then it's gone to waste and students didn't retain the information.

R: Ok that would be last question in this interview. I would like to thank you for being part of the lesson study team and being part of this interview. Go well.

Participant Lecturer (PL 4)

R: The first question I want to ask you is, before you became part of LS, how have you done this part of the syllabus, how did you plan your lessons, and how did you deliver your lessons before the LS process?

P: OK, so basically with the topic of space and shape I make use of 3D models that I got in my cupboard, uhm that I use as part of my lesson just for them to visualise actually the differences between different section within the topic SSO like area, volume and surface area uhm I basically obviously there is the LP the standard LP that we always use that is done before the lesson takes place, I will

plan it like that uhm I would also make use of a printed formula sheet so that they can actually see the different formulae for different types of questions and in class I would always obviously as the traditional way to introduce the topic with them and question them on their background knowledge and I would do it on an individual basis so there is no group work or things like that, but I do allow them to discuss with one another within the lesson obviously with me facilitating them so that they don't go off topic of the lesson. That's basically how I and in most cases I have an exercise prepared for them or I'll take questions especially from past papers as well after doing examples with them I have to do examples with them. But when I do the examples I try to involve them and doing the examples with them instead of me just teaching it. That how I normally do it or would have done it, yes.

R: Describe your general impressions and experiences of participating in this collaborative LS process. How have you improved, what were the major benefits for you and what does it mean to you?

P: OK basically, what I like about the LS process that it is group work effort, a collaborative effort and for me it was very informative because I could learn professional ideas from my colleagues for example instead of just being locked in my class alone isolated. So what is nice is I got to learn other professional ideas from them, which was different to my own uhm and what I liked also is ah we get to share common experiences uhm which I thought was uncommon experiences actually was common experiences in terms of students learning inside of the classroom and having them concentrate in the classroom and sometimes the students their background knowledge is not actually there, I am just giving an example now, and I thought maybe it was something I am doing wrong in my lesson, but with this LS process I got to learn that other lecturers are having the same the same problems and how to restructure a lesson to actually provide the basis of that background knowledge (9: 16)

R: So how have you improved? Then would you say from what you were before to now after the LS process going through two cycles of it. How have you improved?

P: I would say, ahh, that definitely there is improvement although I might not be able to speak of all the improvements that come to mind, but what came to mind is what I notice is uhm instead of solely providing students with knowledge and information, it is more effective to question students' current knowledge in aid of guiding them to obtaining new knowledge that can be built onto current knowledge, I am using the word knowledge a lot (laughs) so basically what I am saying there is instead of the traditional way of teaching students all the time it's also better to actually to question them on what they know and ask them how can they use that in this situation for example for the exercise that we gave them more like a problem-solving approach. It's like a problem solving student-centred approach and the if students are not able to answer then the lecturer can provide more information to them to help them, but it is important that the information must be provided in stages instead of just providing them like spoon feeding them everything at once, so that it helps them to think better and think more independently and uhm I must admit that group work isn't really something that I practice on a daily basis, although I do it sort of in an indirect way like I will ask a student at the back a certain question and somebody else like he would answer and I'll ask another student to add on to that answer and for them to discuss it like that but to put them in groups I haven't done that (11: 37) but I am thinking of introducing more group work in my lessons but I won't do it every day not often because you can't do it every day because obviously we are driven by curriculum and we group work does you have to admit does take good planning and a lot of time, so maybe once every second week or once a week maybe I will have a lesson where they can do it collaboratively, because having students actually learn from each other sometimes provide better light 12: 10 compared to a lecturer just giving them the answers or guiding them, because the students they experience similar contexts then where they are compared to us as lecturers being as a facilitator and, I actually also made notes here it says observing students working

together provided an opportunity to watch how learners learn from each other and became more evident that each student has a different way of thinking and had different levels of background knowledge based on the way they would approach the answer.

R: And major benefits for you? What were the major benefits for you? Out of this LS approach?

P: Uhm, major benefits? I would say what I learnt also is ah sometimes the student can actually guide another student in a group work effort instead of the lecturer being the one to play the facilitator, so what I am saying is what I am learning from this is that sometimes it's also good to provide those students with independence in their learning uhm but what was difficult for me what I realised was difficult is sometimes the students clearly don't know what approach to use to answer the question, ok and if it happens that the other students in a group also doesn't have an idea of what to do then it sort of become a time wasting effort, so and that is where the lecturer needs to be observant to actually be able to identify that situation and provide them with clues or and that is something that I have learn because the lecturer can't just stand back to allow them to do it fully independently the facilitator still has to be there, so looking at the contextual platform where the students are students being guided by students maybe more effective compared to the lecturer because of the student-centred approach, because they understand sometimes better than what the lecturer understands them, so I think getting it from a friend might make it easier to understand compared to the lecturer guiding them. 15:00

R: OK moving on to more general questions. How and to what extent have you improved your instructional strategies in your lessons as a result of your participation in lesson study and collaboration in a team? Describe the improvement and the specific element of the process which facilitated your improvement.

P: OK so what I liked about the LS is that it does take on a problem solving approach as well as a student-centred approach, which gives the student the opportunity to actually sort of having learning in their own hands so having learning in their own hands gives them that responsibility for their own learning which I found an improvement for my way of teaching because the way I have done it in the past is that like I will provide students with the topic and I will have them discuss it individually and having it done that way some of them might have struggled in terms of confidence because now they have to speak in front of the whole class where as having certain groups they would then have the confidence to speak within a small group, uhm so having learning in their own hands might be beneficial because it is now their responsibility to learn and if they don't, if they go off topic for example then it becomes a wasted lesson for them, so it sort of motivates them, it gives them that inner motivation to pursue the lesson in a way that they can learn collaboratively and collectively. Other improvements? I want to say being an observer within the LS process what's nice this time is that I wasn't part of teaching the lesson I had to be an observer I got to sit as an observer, just to view from outside the box in other words because there was, normally I am inside the box, but now I got the opportunity to be out of that box and to see how other people teach a lesson, so for me what was beneficial is getting to see another professional teaching the same topic that I might have done before and what I noticed is the lecturers continuously walking around looking at everyone and viewing everyone because for me normally when I introduce a lesson I would stand in front without realizing that I have been doing that and that is something I have learnt and maybe just to walk around and sometimes once I pass a student then they will ask a question because I am there because previously he had to call me and maybe be too shy to ask because everybody will hear.

R: So, how did the LS process improve your ability to focus on how your students think and learn? If it did, can you give an example? If it did not please explain why not? 19: 15

P: Obviously being in the teaching industry, we are also driven by curriculum and certain topics have to be done by a certain time, so me being in front as a teacher sometimes I realise my focus is so much on that and although the students might not be up to standard with what I am teaching uhm being in the LS, being part of the LS I had the opportunity to view one group of three students or so, for me that was an eye opener and I had a better opportunity to focus more on them and realizing that, once I get to my own classroom once again did it with my own students I realise that it will help the LS process actually provided me the ability to put myself with the students and actually try to learn with them and sit with them because in the LS I sat with the students although I wasn't communicating, they did try to ask me questions and I didn't give them answers to answer them I just questioned them on their questions like for example "do you really think have to include the side of the shape" for example and then it made them think, so I got to see it from a student perspective within a teaching environment which I don't normally get while I am in my own teaching environment and that student perspective uhm made me realise that sometimes the students are really trying their best 21:20 although they are struggling and although they are not getting the correct answer, but they will participate.

R: So, are you starting to think differently about students now?

P: I would say yes, especially in terms of the group work, having to see them, having their learning in their own hands, because that is basically what the student approach is about when learning is in their own hands with the facilitation of the lecturer, uhm I would like say from the LS process onwards I would actually focus more on walking around and standing by a couple of students maybe when I checking what they are doing and question them on a softer note in comparison to in front of the whole class.

R: So, while the LS process was being done, did you implement any of the

elements of the LS process in your classes just to try it out maybe or any element of it, and not necessarily the whole process? Did you use it and check how it works?

P: Uhm, an element that I had used and emphasised more on was the student-centred approach, not necessarily putting them in groups because of time constraints but I have used the student-centred approach and problem-based questions as well and what I have done, actually I have taken questions from past exam papers and I would give it to them and I would tell them to solve it using their books as a guide giving them less information like we did in our LS for data handling as we are busy with it now. So, the formula was there. Like last year when I have done data handling I used the same document and I did all the questions with them, but this time around I only did question 1 with them and I said "right guys ok now you are going to do this on your own, you have got all the formulae and I am here to facilitate and you are going to do it on your own and they did questions 2, 3 and there were a few students who did up until question 5, in one period and I think it worked much better for data handling because data handling is also less complex compared to certain other topics, and they have their textbooks so they and they could use it to help them and this all because of LS and I am already implementing some elements of LS.

R: From your impressions of the LS process and your experience to what extent did the involvement of the researcher (manager/education specialist) as a participant observer in the lesson study process in every part of the lesson study process impact on the improvement in your instruction and lesson plans? 26:00

P: What I can say is that more insight was provided in terms of the student-centred approach and the collaborative and the group work as well because I haven't used group work before, so I would say the involvement of the researcher (manager) brought in different ideas of teaching and learning compared to my own normal way of teaching, uhm, come back to this.

R: OK. How did the participation and the collaboration between the participants together with management in the LS process bring about a positive and supportive environment and how did your relationship with your manager change through the process?

P: I am going to start off by saying I enjoyed having the manager in the classroom with me because normally how it is when I am in the classroom, when I see the manager in the staffroom, or sometimes we also have the manager to do class visits where they observe us as the lecturer, but in the LS situation we got to associate with each other on the same level and I think that was quite nice because it was informative also to have the, to actually share experiences with the manager and I also realised that, although they are called the managers they actually do share and understand the experiences we have within the classroom, because they do also have their own classes as well, uhm, it was non-threatening, because normally a manager will come to your classroom for an appraisal, but here the manager was one of us, and I think on that note it definitely brought in a positive experience because we got to share our experiences afterwards as well and what is nice to know is what is good to know is that some of the experiences we shared were also common like I picked up certain things we actually up certain things that had a bit of humour in it as well the way the students would answer the question and the one would tell “but how can you do that, how can you add that value if it is not part of the shape” you know there was a bit of humour in the way they laughed also in that, but I would say from managerial point of view like, from their point of view, it was quite good to work with them on the same levels in participation and collaboratively.

R: So, what benefits were there for you working participatively vs. alone for example when we planned a lesson, when we were debriefing, being part of the observation etc.?

P: Working alone is obviously what happens more on a daily basis and working together like we have done in the LS process is not something that happens every day, so benefits I would say is getting to learn other professional ways of thinking that is different to my own and that sometimes also can influence my way of thinking, in terms of teaching and learning inside of the classroom and uhm and we become more open to share knowledge with other people and that was what was very positive and very good because nobody was hiding anything and sharing knowledge with each other was done so in such a positive friendly manner and an open way that, which for me was very beneficial, because it made me think more positively in aid of teaching and learning, and for me the greatest benefit was the sharing of experiences that were common to my experiences and getting to learn how the other colleagues (participants) would teach and learn by questioning for example that is what I enjoyed about the LS process is that in teaching a lesson sometimes questioning students can also be better that just giving them the introduction, rather to question them and have them take a major role in bringing the introduction into the lesson. 32:00

R: How can managers use the ideas and the effectiveness of the LS process in the teaching of space, shape and orientation at TVET colleges and how can they use it in other parts of the syllabus and other subjects? How can this assist in looking differently at the curriculum?

P: OK I would definitely say that managers can use it by first of all implementing the LS process as maybe part of their job description for example, not on a not in a forced way but maybe like on and not also very often, and maybe in an informal way, because obviously we have our daily duties and this is now something we have to add on already to what we are currently busy with, so I would definitely say they can start by maybe implementing it because it provides an opportunity for professional individuals to actually work together on a specific topic to develop professionally because it will provide a mutual development for all lecturers involved as well as for the manager because now the manager gets an opportunity

to actually share and to view our (lecturers) experiences inside of a classroom and in that way it actually builds a better relationship because we are now more involved, we socialise more on a professional level as well as a personal level and in between with more focus on the professional side. And as a manager, if I was a manager I would I would actually like this concept if I was granted the opportunity with time, because I know for a manager there is teaching as well with admin and administrative work, filing and everything else that is added on to it. Yeah, I would definitely by starting to implement it.

So managers becoming part of it helps to share in the knowledge and it is not just a matter of the manager telling you to do something and he or she walks away but this is an opportunity for them also to see what actually happens in the classroom, because managers come from classrooms and when they become managers they sometimes forget what happens in the classroom and what it was like and loose site of it. This is an opportunity for them to become part of the lecturer on the same level because we have to accept that students change over time and teaching and learning changes over time and individuals change over time, so ten years ago the attitude and motivation of humanity might be different compared to now, because for students and for lecturers there are more things in the modern world, more and more things are becoming available in terms of technology, cell phones are becoming more easily accessible compared to ten years ago so the focus of students are different and for the manager to participate in the classroom through LS helps him/her not to become obsolete in his/her way of thinking because its no use there are managers, but he is not in touch of what is happening in terms of technology, the classroom and the subject. This provides him/her the opportunity to remain updated and get to terms of what is happening in the current time.

R: And the last part of the question as to how this can assist in looking differently at the curriculum?

P: OK, first of all we have to accept that from my experiences that the curriculum

does not take into account the social context of our students and based on my experiences the curriculum is a sense of dictatorship; we have to follow what curriculum says and we have there is no way we can leave certain things out or/and add something that is not part of curriculum so we have to follow the curriculum to the tee, uhm maybe if you look at the topics itself 39:07 I don't know, it sounds very far off or it might be difficult to do but that assumption of prior knowledge being in place shouldn't be there, and if you look at curriculum the assumption of prior knowledge is there.

R: OK, OK I see what you are saying, yes.

P: In terms of like, in order to get into NCV for example you need Grade 9, and yes they have Grade 9, but we don't know the history of how well they did in Grade 9 as an example, and now they come into level 2 on the NQF scale which is equivalent to Grade 10, we assume that they can do Grade 10 work and that is what for me the curriculum is assuming, so I am not saying the curriculum has to change what is there maybe if curriculum could add in or amend here and there or somehow something to provide a better foundation for these students to actually start off a certain topic, for example there is a if I look at the mathematical literacy textbook the way the example starts off, it starts off with basic examples which is very good and sometimes even though its basic examples from my own experience, I can't generalise for other colleges, but sometimes even for those finer simple examples, the students aren't able to understand it by reading it. So, I don't know if there is a way.

R: So, what do you think then how can LS assist in looking differently at the curriculum?

P: Maybe how the LS process can help is exactly what we have done with this study, although it will take time but maybe to also sit together and maybe divide up the certain topics like participant A can have a look at topic 1 and maybe

participant B can look at topic B etc. and develop some exercises where the textbook might be too complicated and have that maybe viewed by the rest of the lecturers almost like having a LS having a collaborative lesson plan and maybe to also have a collaborative exercise 42:45 that can help maybe link the student's prior knowledge to what is being asked in the textbook. Even the curriculum can be lesson studied, it will take time, but it can also be done. And from a management point of view uhm, they can also through LS get the opportunity to see where the problems are within the curriculum and within the teaching and learning process and maybe they can also be involved in developing these exercises since they have the experience and managers do also teach as well but for the major challenge I can mention already is time.

R: Thank you for that. To what extent did working collaboratively together in participation in the same field for a common purpose assist in bringing about collegiality in the group? (Explain collegiality) and what can managers learn from this?

P: OK I would definitely say that LS gave us the opportunity to converse with each other on both a professional level and a social level and it developed on our professional relationships within the college because we could share experiences, we could share positive experiences as well as a few negative experiences but those negative experiences sharing it also made us feel more comfortable because it wasn't an experience by one person and having the managers there with us on the same level as us also maybe gives them the opportunity to understand what's happening inside of our classroom, so I would say it benefited collegiality in a positive way and in a developmental way as well. And managers can also learn that collegiality is very beneficial for managers and lecturers.

R: OK. In which way did the sharing of ideas and knowledge in the LS process increase your confidence and how did it motivate you? Did it improve your confidence and are you now seeing yourself as more confident after the experience with LS and do you see yourself differently now in terms of your self-

esteem?

P: Yes definitely, I can start by saying LS process did motivate me and my confidence has also increased as well so it is all positive and what motivated me is when we shared our experiences after the lesson took place, before the debriefing with the manager (researcher) there was also an informal debriefing with each other as well which I found to be motivating because there were common experiences and there were common observances and that motivates me because it also shows that my way of thinking is not uhm is not in a bad way it's more of a reality is what we are facing the reality and also sharing points of view that getting to hear others points of view that might have been different from my own also sort of altered my way of thinking in terms of the student-centred approach and that is something that also motivated me because I although at first I must admit I stand in front of the class and there were times when I walked around but sometimes I seem to forget that I need to walk around also which reminded me and that also benefited me because of working together participatively and collaboratively.

R: So, on a scale of one to ten where was your confidence level before the LS and where is it now after the LS?

P: OK so obviously I won't rate myself to be ten because I always believe there is always room for improvement, so I would say I went maybe, I went from a seven to a nine I would say, yah.

R: That is very good to see it improved your confidence in that way. 48:40

P: (continuing) because, independent of the whole LS process we were given the opportunity to collaborate and communicate with each other on a level that we don't always get uhm so I think the whole picture of LS was positive because us together sharing our common professional experience.

R: Uhm, in which way and to what extent did the manager in a participative capacity contribute towards building that confidence in you and empower you through the lesson study process?

P: Besides you (researcher), my direct manager is a very good manager, and the way she already walked inside of the classroom, she just has that positive energy and wanting to contribute and participate in the LS, automatically motivated me also to be part of it because I could, like we were, what's nice is about the LS process although she is my manager we were on the same level and I think that also contributed with the confidence of the process and I would say it was a bottom-up approach for me that provided confidence because I could communicate on a level where not get every day for example, although my manager is like that, we can communicate on that level.

R: What role did the manager play in the LS sessions which you were a part of recently and what do think should a manager's role be in the LS process?

P: OK for this LS process the role that was played by the manager was basically the same as a lecturer I feel it was the same because for them obviously for them they can also view it from a managerial perspective as well as a lecturers perspective uhm, but I think their role in this should definitely be involvement and a very important role because 52:07 the manager was governing the whole LS process. The manager made sure that they were following what needed to be done within a specific time and I think the it was planned very well and prepared very well because we had the opportunity to edit and go back to the lesson plan within our weekly meetings which was organized by the manager (researcher) and I would say that a major plus was the level of communication via emails of the manager (researcher) and everybody was always included in the emails and we were constantly updated and be made aware of what changes was made, ways of improvement, how an existing lesson plan can be edited for improvement for the sake of supporting the student-centred approach.

R: So, do you think a manager should be part of the LS process or should they not be part of the LS process?

P: I would say, definitely the manager should be part of the LS process and be involved in the LS process, I am not sure to what extent but they should definitely be involved, maybe not fully involved but they should be made aware of the of the lessons that is taking place, the meetings that is taking place and maybe they can sit in the meetings as well to gain insight on what's happening because they have to know what is happening inside of the classrooms, and in fact I think they should actually be the ones to initiate the LS process if it is to be part of a college system.

R: OK thanks. In which way and to what extent did the LS process through participation and collaboration bring about respect and trust amongst the members (lecturers and the manager)? 54: 24

P: OK, uhm, I would say it brought about great trust and relationship between us because of sharing our experiences with each other before and after the lesson has taken place both on an informal and in a formal manner uhm getting to hear that there are common experiences as well as uncommon experiences. There was respect for my views and vice versa and the LS is a good platform for bringing about more respect and trust amongst colleagues and amongst colleagues and managers. The LS process provided an opportunity our trust and respect for each other to grow because we as an example I can say no one spoke over each other's words. Everybody had a fair opportunity to speak and share their perception of teaching and learning and having the opportunity to share of their experiences also brought us closer I would say it brought us closer together, for example I got to be with a lecturer that is not only in NCV, he is also in a different program teaching mathematical literacy and through the LS process I got to interact more with him which I never did before and this brought about great camaraderie between lecturers teaching in different programs and this was a great

new and positive development brought about by participating in the LS process and the collaboration. In the process I learnt from him and he learnt from me. In the process of the collaborative process of LS it resulted in a better relationship, more trust and more respect for each other in terms of teaching and learning and in that way it also boosted our confidence as a professional individual and gained more professionalism as well.
R: Do you think that LS can be used as a good PD tool?

P: What I liked about the LS process, it is very contextualised, meaning that we are in the direct source of learning where things happen and happened and it is not viewed from an outsider, we actually it is being viewed by the people who are in the process of teaching & learning as well as the managers of those lecturers and learners for example so it is not a manager talking to you, everybody is involved. The manager is involved, lecturers are involved and students are involved and that forces a manager also to become more involved in the classroom of the lecturer without feeling threatened and that is also something that definitely came out from this LS process. I did not feel threatened by the manager (researcher). The LS process created the platform for us to converse with each other in an open and trustworthy trusted way and I would say definitely that this should be a process that can be implemented within the TVET sector because for me I would say on an academic level uhm where they would say two heads are better than one and perfectly suits the function of LS.

It also brings to the fore that managers need to be more open to others' ideas and not to be dogmatic in the way they think but be more open to new ideas.

R: Now that you were a part of LS process how would you start your own team implementing the LS process at TVET colleges and for your subject and how will you get managers involved in the process?

P: OK so first of all I would start off with an information session, introducing the

topic of LS to them and explain to them the benefits of it. For example the main benefit is having a group work a collaborative input uhm to a common topic within the classroom and I would motivate it to managers by sharing my experience for example getting to learn professional ideas of others other than your own and taking you outside of that daily isolation that we usually experience as individual lecturers in the classroom with the students without others that is how it is normally done every day. This provides the opportunity for a group work effort where professionals can actually build on uhm working relationship as well as a personal relationship as well as building and sharing of ideas and knowledge. 1:00:57 so I would say definitely maybe have a presentation even prepare uhm like a power point and present to them (managers) the experiences and maybe ask them for input from their side, although they haven't experienced it but it will be nice to maybe to get their views on how it can be changed or improved or amended and if they feel that they can also add on their professional opinion on how to improve it that sorts of involve them already without them knowing it.

It is a benefit for TVET colleges because LS is different from the norm, meaning that the norm is the lecturer being inside lecturer in the classroom and every year probably lecturing that same topic in the same way whereas LS provides a platform for this topic (SSO) to be discussed and not necessary force a person to teach differently but just to hear other people's ways of thinking and having that group work or collaboration opportunity, there is no way that no learning can take place, so I would say guaranteed that LS is a benefit for the entire TVET sector, because professionals of different ages gets to share their experiences with each other that some might find to be common and some to find uncommon and experiences that happens to be the same once shared actually puts a person at more ease just to say that "oh ok so I am doing my job properly it's just that because of the context the students might struggle a bit more with this topic than with that topic. So, what's nice is that the LS is very contextual and can be contextualized towards the benefit of the TVET sector.

R: In which way did the LS process within a team in the participative process of collaboration empower you to make decisions freely?

P: OK, in the team I would say that we, the way it took place, it did empower us to make decisions freely which was restricted in a sense that one person might have one idea and two others might have another idea that is common and obviously that will overpower my way of thinking, but that is not a negative thing it just shows that there are better ways of doing it in comparison to my own way of doing it for example I might have mentioned a certain idea another one might mention a certain idea and after the ideas, in that sense we were free to share our ideas and after that after discussing and discussions there has making a decision on one specific idea uhm involved us all it wasn't just a forced way of it wasn't dictatorship.

R: What suggestions would you make to managers to effectively implement LS at this college and the whole TVET sector?

P: Definitely one thing I would say how the college sector works, we work with different lines of management as well as other businesses and other types of companies so I would start off by saying from a manager's point of view I would not say they should just implement LS 1:06:14 25/Nov to lecturers.

P: (continues) I would say it will be better rather to prepare a presentation and maybe take it to the line of management that is above them, and convince them based on the benefits and the experiences of the participants and that the manager (researcher) may have in the LS process and once having that confidence in the upper line of management I feel it will be more powerful once it is studied on that level and then take it further to get management buy-in and once they have that management buy-in it will be easier to implement to the line of management below their own management for example us lecturers as managers of the students. It will be good to first convince the senior managers and have them to be made aware of the scarcity of such an activity like LS. LS is not

something that according to my knowledge is known well in SA. In fact, me being having the opportunity to be involved in this makes me champion.

R: If you had the opportunity to be the champion, because each of you is now a champion of the LS process, how would you further LS at this college?

P: Yes, I will be willing to participate in that process to relate my experiences I had from the process if the opportunity arises I would love to be part of it. Definitely I feel it will boost my confidence levels in terms of getting to see new faces and maybe lecturers of different experiences from a different campus as well because even us as lecturers we are restricted to knowing each other from the same campus unless we go for memo discussions etc and that is also restricted to one subject which is mathematics, so maybe becoming a champion for LS can provide an opportunity to speak to other lecturers from other subjects,

R: OK we are almost coming to the end now. Which ways can you suggest can the LS process be modified to include managers in a bigger way to make the LS process more effective and transform colleges? In many instances where LS is implemented or researched there is no management involvement. An instruction is given by a manager to try it out and the team implements it. In your opinion do you think there will be any benefits in implementing lesson study in this format where the education specialist is a member of the team, throughout your college?

P: Basically, I would say the way it has been done has was done in a good way and I feel there is not much that can be modified because I feel it was done in a very effective manner and the fact that the manager(researcher) was involved in the whole process I would say is a bonus and it should not be done without the managers involvement.

R: What negatives were there for you, if any, in the experiences in the LS process?

P: Uhm, I would not say there was anything negative necessarily, but if you look at the context with the, if I look at my own context in my classroom sometimes time is a factor when it comes to a problem-solving approach. The only aspect I would say of the whole thing is I would not say time management, time management is not a bad thing, uhm it is more of how long it takes for it because the problem-solving approach depends on the student's ability to learn independently or in a peer relationship with his students. It does depend on the calibre of the students and our students are not ready for problem solving yet although in our case, in our example, students were not left totally on their own as we assisted them with clues etc. We have even modified the problem-solving approach to suit our situation.

I also think it is a good idea to timetable LS in the college timetable, but then lecturers might feel forced to do something and might not be voluntary and might take up time that they could have spent on other administrative tasks or other classes to teach and learn uhm because if you do look at the lecturers schedule we have quite a lot of periods to teach and if it going to be timetabled it might bring about a negative about it and pull out of it. For myself if it was timetabled, I would say it should not be timetabled like often like maybe once a week like we have done it and it should not be in place of a free/admin period because lecturers might feel that is their time to do their admin for example because we have to have acknowledge that this LS process and activity is an add on to our current workload as well unless it can be replaced with something that will keep the workload sort of the same. A good idea is to have LS, but assistant lecturers can take the LS participants classes and that idea makes sense because it won't add on to the time of the lecturer. Classes can still go on and the students won't lose out and their time will also not be wasted.

In general, I would say that the LS process has got more positive outcomes than any negatives not that there are any negative outcomes but it has got positive outcomes because it just provides an opportunity for both lecturers and managers

to be involved in something different and in the modern world we need change and I think this change can be for the good if it is implemented in a way that does not add on time on to the existing schedule of lecturers.
It was a great learning curve because if I speak for myself as an individual, I got to learn other professional points of views from others and for example setting up an activity using colour instead of using black and white because it attracts the attention of students for example and overall I would say I did learn quite a lot in terms of the student-centred approach and I have studied that approach as well in the honours program for example so for me to see it in practice was quite nice as well and I would definitely recommend something like this to the TVET sector.

APPENDIX U: HANDWRITTEN INTERVIEW TRANSCRIPTS WITH STUDENTS

INTERVIEW QUESTIONS FOR STUDENTS AFTER THE FIRST RESEARCH LESSON

1. What did you enjoy most about the lesson?

Do not understand the question
Teamwork, learn better from peers.
Did not enjoy the lesson as it was not specific

Would like more of these L.S process so that more they can be observed

2. What did you enjoy least about the lesson? Why?

If teachers can go around and see what students are doing wrong.

3. What did you learn?

Working with each other is better than working on your own
Forgot to use Pythagoras and to use it.

4. What can you do now (or do better) that you could not do before?

Questions was differently worded
Confused with perimeter and area
Can do Pythagoras. Must look at everything.

5. Why can you do it now (or do better)?

It has been explained

6. What prevented you from doing it (or better) before or what did you not understand before?

Thought that I had to calculate only the sides

7. What was the error (or misconception) in your thinking before?

- confused perimeter with area

8. How can you improve or what can you do to improve?

Do more of these types of
Practice more

9. Which aspect(s) of the teaching worked best for you?

Teacher interacting with the L.
Students to work solutions on the board
given the questions seperately
as teacher speaks, writing it on the board.

10. If the same lesson is delivered to another group, what would you change? Why would you change that aspect?

change wording of the question, make it more
specific
Prompt student to work out a side, if needed

Check prior knowledge very well. Can have a
survey
Use more technology
Identify weak students. Ask them what are they comfortable
with.
More projects

- explain to students the LS process
Would u like more of this to happen, not just in
maths, but also in other subjects as well?

INTERVIEW QUESTIONS FOR STUDENTS AFTER THE SECOND RESEARCH LESSON

1. What did you enjoy most about the lesson?

L from my fellow students and learn a few thing you did not kn
before. Time myst. Enjoyed th way th q were asked
Must read the question correctly and group is diff and l to work with
one anothr

2. What did you enjoy least about the lesson? Why?

ee should have checked th answe for stud who were done.
Shouting at out answers from students.

3. What did you learn?

Engagement with outher students
Need to read questions properly. Group work
More ways in doing th question

4. What can you do now (or do better) that you could not do before?

Read questions repeatedly. Not to hurry
reading with meanery.
Calculating areas. Applying a certain formula to a certain question

5. Why can you do it now (or do better)?

Opportunity to engage with students and lecture
Practice makes perfect. 2 a week groups
Understand it better

6. What prevented you from doing it (or better) before or what did you not understand before?

Understand the A of circle (letter)
Linking words and mathematics

7. What was the error (or misconception) in your thinking before?

Did not take mathematics seriously
One formula for each question
confusing x and + with p and over, confusing Q jacks.

8. How can you improve or what can you do to improve?

Engage with otter
go over your maths everyday
Make mistakes

9. Which aspect(s) of the teaching worked best for you?

Explaining in depth
breaking up the questions
Extra l to help and guide and maybe the guest lectures

10. If the same lesson is delivered to another group, what would you change? Why would you change that aspect?

Nothing to change
Explain in another langue & the student

Students want more of LS, students can
that students struggle.
In group work you learn a lot.

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APPENDIX V: EDITOR'S DECLARATION

WordWorks

TO WHOM IT MAY CONCERN

DECLARATION OF EDITING

DEd THESIS: Mr Shaik Mohammad Hassan

I, Louise M Grobler, as a private language practitioner and a registered, accredited member of the SA Translators' Institute, hereby solemnly declare that I have edited Mr Shaik Mohammad Hassan's DEd thesis, **Lesson Study as a Management Strategy to Improve Performance in Space, Shape and Orientation in Mathematical Literacy at Technical and Vocational Education and Training Colleges.**

I marked some errors in the bibliography and in the text for correction by the author.

I may be approached via my contact information on any queries on the editing of this document.

Louise Grobler

BA, BEd, MEd

12 January 2021

SATI Membership No. 1001101

Let your Words Work!